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PHASE I REPORT:

TOPOGRAPHICAL SURVEY AND HYDROLOGICAL ANALYSIS

OF THE

WALLIS SANDS AND PHILBRICK BROOK MARSHES

Submitted to

THE TOWN OF RYE, NEW HAMPSHIRE

Prepared by

NORMANDEAU ASSOCIATES INC.
25 Nashua Road
Bedford, New Hampshire 03102

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TABLE OF CONTENTS

LIST OF MAPS

LIST OF FIGURES

1.0 INTRODUCTION

1.1 BACKGROUND

The Town of Rye has been directly involved in the assessment and restoration of its coastal marshes since the New Hampshire Coastal Wetlands Mapping Program completed its Phase 2 report (NAI 1986a) outlining the impacts of development on the town's salt marshes. As a follow-up, wetlands and associated road crossings were investigated for the town's six coastal watersheds (NAI 1986b), with particular regard for drainage problems associated with culvert inadequacies and tidal restriction. These studies, the personal observations of local residents, and previous local studies (Chick 1979, Short 1985, Simpson 1986), point out the complex role of development in impeding tidal exchange and freshwater runoff, and salt marsh degradation.

1.2 NEED

Salt marshes have only recently come to be recognized for their function and value in coastal and estuarine systems. As the result of extensive ecological research and environmental awareness over the last 25 years, a consensus has steadily grown in favor of salt-marsh protection (Nixon 1980). Federal, state, and local legislation has recognized several values associated with salt marshes, including:

- fisheries
- pollutant assimilation
- shoreline protection
- flood control
- wildlife habitat
- aesthetic appeal
- education
- scientific research
- recreation

Fundamental to many of these functions is the free exchange of tidal waters, via tidal creeks, between marshes and their parent estuary. The exceptional productivity of salt marsh systems is largely attributable to the "energy subsidy" that tides provide. Tides transport nutrients, detritus, and juvenile fish and invertebrates in and out of marsh creeks, and allow periodic access to the marsh surface by estuarine fish in search of food (Daiber 1986, Nixon 1980). In addition, salt water inundation limits the growth of fresh water plants, while allowing salt marsh species to flourish. Regular tidal flushing allows freshwater to leave the system, thus maintaining sufficient aeration of the soil surface for plant growth (Burdick and Mendelson 1987, Cooper 1982, Groeneditk 1984). At the same time, peat accumulation is promoted by saturation of the subsurface layer.

Unfortunately, most coastal development, and particularly the design and construction of roads, bridges, and canals, was well underway or complete by the time the vital link between estuaries and marshes was recognized (Clark 1977). With the level of development in the northeastern United States, most coastal marshes have been impacted to some degree by the effects of surrounding development either directly by filling, or indirectly by the interruption of tidal exchange (Nixon 1982). The threats of direct impacts have largely been eliminated by legislation and enforcement at many levels of government. Despite protection, however, many coastal marshes continue to be degraded by the long-term effects of tidal restriction. This degradation is evidenced by large areas of peat deterioration ("rotten spots"), intensified mosquito breeding, and invasion of salt marsh communities by fresh and brackish water plant species. Because of past disturbances, many coastal marshes are now in need of active restoration and management efforts to restore and maintain their vital functioning in estuarine systems (Cowan *et al.* 1988, Cowan *et al.* 1986, Roman *et al.* 1984).

1.3 GOALS OF THE STUDY

Normandeau Associates Inc. (NAI) is in the process of completing Phase I of the Topographical Survey and Hydrological Analysis of the Wallis Sands and Philbrick Brook salt marshes in the Town of Rye, New Hampshire.

The objective of the current study is to provide the physical basis for tidal restoration in two of Rye's salt marshes located in the Wallis Sands and Philbrick Brook watersheds. Phase I is an evaluation of existing conditions in the two study areas, including hydrology, topography and engineering features, and general recommendations for achieving marsh restoration. Phase II, to be completed in mid-June, will recommend specific engineering and drainage improvements to achieve optimal tidal flushing and flood protection. Phase III is scheduled for submission by the end of June 1988, and will assess the impacts of drainage alterations on surrounding development, including properties, septic systems, structures, and roadways.

This report summarizes NAI's work to date on Phase I. Tasks completed or in progress include: 1) a detailed survey of existing drainage features, their location, elevation, condition, and volume exchange capacity; 2) volume study of marshes including creeks, ditches, and marsh surfaces; 3) tidal exchange determination via water budgeting; and 4) recommendations for improved tidal exchange for salt marsh restoration.

1.4 DESCRIPTION OF STUDY AREAS

1.4.1 Wallis Sands

The Wallis Sands salt marsh complex lies landward of Route 1A, across from the Wallis Sands State Beach, and includes approximately

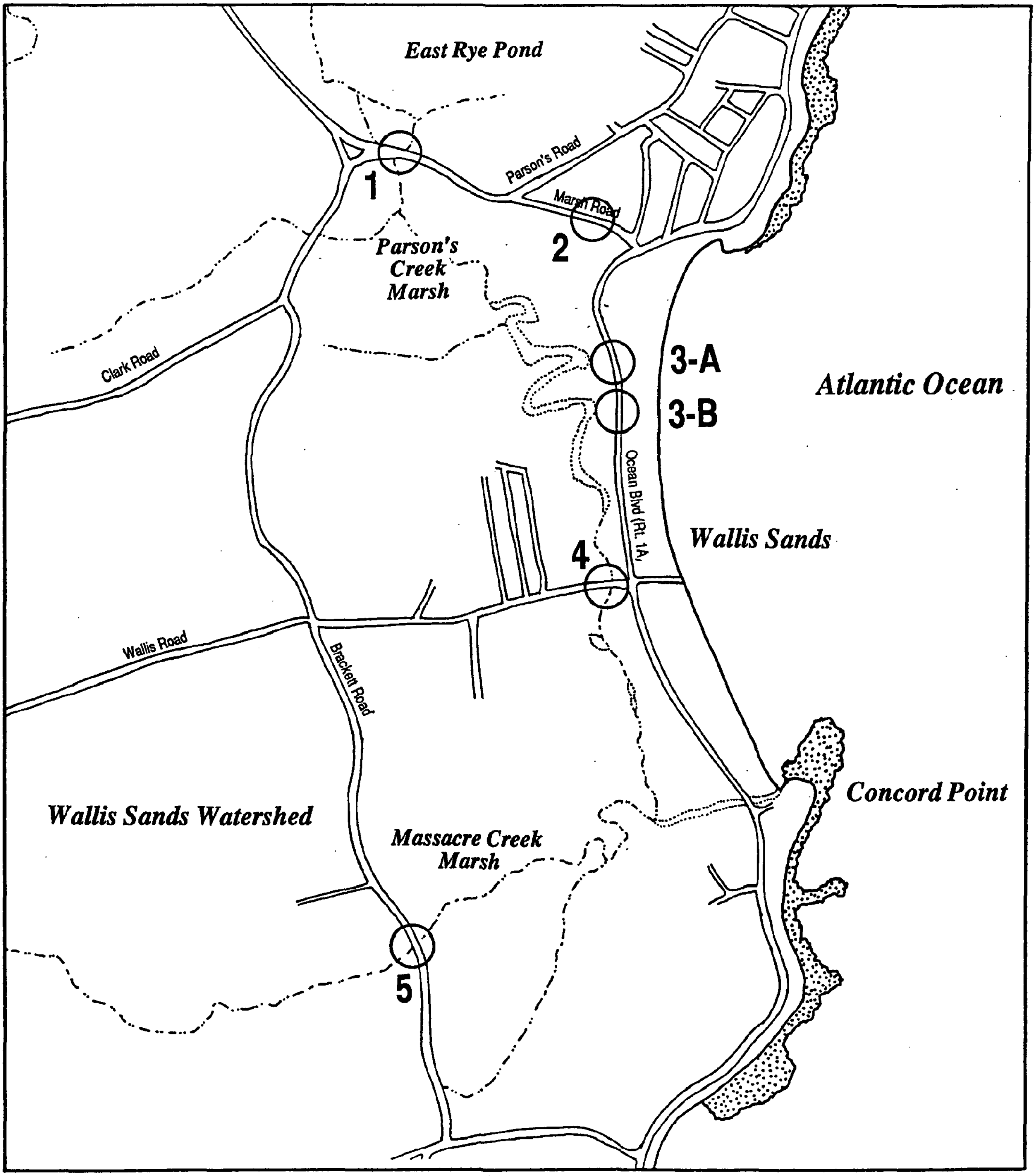
185 acres of intertidal marsh, high salt marsh, and brackish tidal marsh. Tidal waters are exchanged at Concord Point, near the south end of the salt marsh system (see Map 1).

The Wallis Sands marshes form a highly complex system that includes the tidal portions of Massacre Creek and Parson's Creek drainages. The Massacre Creek marsh drains east-west, and joins the Parson's Creek drainage before exiting to the ocean via Concord Point. The Parson's Creek marsh originates at East Rye Pond and extends south, paralleling Route 1A, to the confluence with Massacre Creek. Massacre Creek is generally well-flushed by tides. In contrast, numerous factors restrict tidal exchange in Parson's Creek, and have resulted in degradation of the salt marsh community.

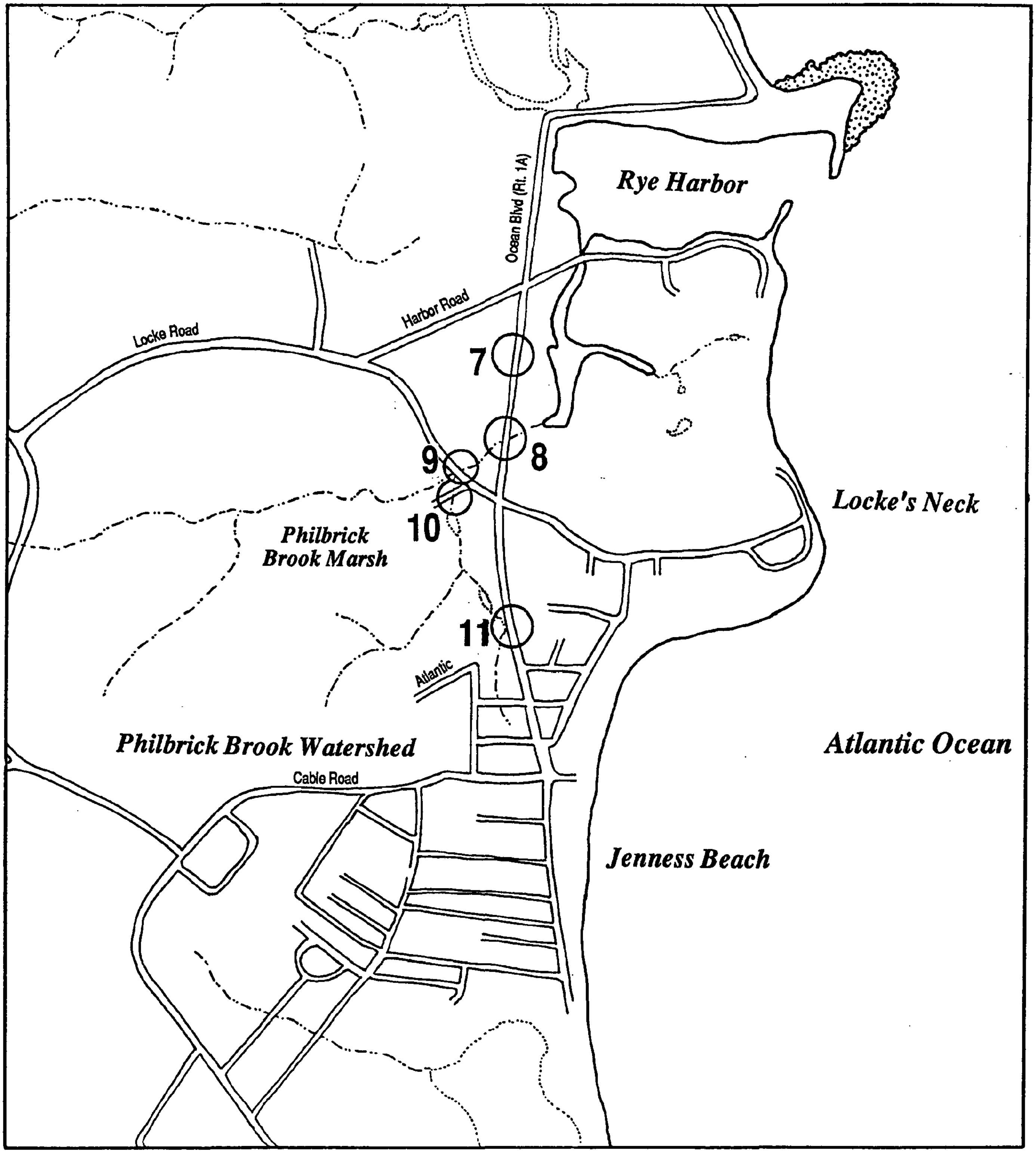
1.4.2 Philbrick Brook

The salt marshes of the Philbrick Brook drainage lie south and west of Rye Harbor, and consist of approximately 100 acres of intertidal marsh, high salt marsh, and brackish tidal marsh. Tidal communication with Rye Harbor and the ocean occurs via the channel under the Harbor Road Bridge (see Map 2).

Most of Philbrick Brook marsh occupies the area east of Route 1A and immediately south of Rye Harbor, and receives generally good tidal flushing. Two culverts connect this large area with the relatively smaller marshes of Philbrick Brook to the west of Route 1A. Tidal exchange in the Philbrick Brook marshes west of Route 1A is restricted by improperly placed, undersized, and deteriorated culverts, and by old stone walls that impede the drainage of water from surface pannes.



Map 1. Wallis Sands Study Area. Points examined for tidal resrictions are circled and numbered.



Map 2. Philbrick Brook Study Area. Points examined for tidal restrictions are circled and numbered.

2.0 METHODS

2.1 EXISTING FEATURES

Drainage features of the Wallis Sands and Philbrick Brook marshes were surveyed by aerial photo-interpretation and photogrammetry, coupled with ground-truth surveying and observations. Working maps (1"=200' scale) of each marsh were prepared from recent 1"=1000' aerial black-and-white photographs, to locate major tidal creeks, ponds, and mosquito ditches. Culverts, sluiceways, bridges, and other engineering features were assessed in the field as to location, size, elevation and condition.

Elevations are given relative to National Geodetic Vertical Datum (N.G.V.D.), also referred to as Mean Sea Level (MSL) of 1929. This datum conforms with U.S.G.S. Topographic Mapping and Coast and Geodetic Survey benchmarks, and therefore allows measured water levels to be compared directly with land surface elevations. Tide tables, such as NOAA Tide Tables and those reported in newspapers and fishermens' calendars, generally give elevations relative to local mean low water (MLW). Local MLW is determined at National Ocean Survey (NOS) stations at various locations along the coast. For Rye, the nearest NOS station is at Jaffrey Point on New Castle Island. At Jaffrey Point, local MLW is at -4.14 ft. N.G.V.D., based on measurements during the 19-year tidal epoch that ended in 1959. Tide table elevations can be transposed to USGS Topographic Maps by adding approximately 4.0 ft. Thus, a high tide of 10.0 ft on the tide table can be expected to reach about 6.0 ft N.G.V.D. on local USGS Topographic Maps.

2.2 TOPOGRAPHICAL SURVEY

As stipulated in the original RFP, existing 1"=1000' aerial photographs were used to establish topographic contours on each marsh for the purposes of estimating marsh volumes and flood elevations. With photography of this scale, the maximum topographic resolution attainable is a contour interval of five feet. In order to make the most effective use of the existing photography, a contour line was determined for the approximate marsh/upland edge, with additional lines at five feet above and below this elevation. These contours will provide the basis for estimating the volumes of creeks, ponds, ditches, and other water bodies within the marsh basins. Volume estimates are refined by field observations of creek and pond depths, and by field surveying of selected marsh features.

2.3 HYDROLOGICAL ANALYSIS

The "normal" hydrodynamics of each salt marsh system are being assessed using a water budget approach, which involved direct measurement of volume exchanges during a spring tidal cycle on 16 March 1988. Volume exchanges were measured at selected points in each drainage system, with particular regard for likely points of restriction such as road crossings. At each sample location, water level, flow direction, flow velocity, and channel cross-section were measured at regular intervals from the onset of ebb tide, through low tide, and up to subsequent high water approximately 12.5 hours later. Representative points of freshwater input that were non-tidal were also sampled to estimate surface water inflow to each system during the sample period. Salinity and temperature data were collected during the flow survey to corroborate flow data and document water quality indicators of tidal exchange. In evaluating the data, points of tidal restriction were made readily apparent by large differences in water level fluctuation between adjacent basins. For example, if tidal flow were unrestricted, then water levels on either side of a given culvert would be expected to track one another very closely. In contrast, a culvert causing a restriction would result in greatly reduced water level fluctuations at its landward end relative to the seaward end. Points of restriction were targeted for further evaluation by water budgeting. The estimated volume of each marsh basin, coupled with measured inputs, outputs, and water levels, will allow a water budget to be prepared during Phase II of the study for each basin where tidal restriction was observed. Water budgeting involves balancing the measured inputs and outputs from basins of known (estimated) volume, to determine the additional pipe or channel needed to achieve adequate volume exchange.

Stormwater runoff volumes for each marsh basin were modeled using HEC-1 (1985) computer simulation for 10-year, 50-year, and 100-year storms. Tidal flood elevations for storm surges were obtained from U.S. Army Corps of Engineers Tidal Flood Profiles (COE 1980).

2.4 RESTORATION NEEDS - CONCEPTUAL

For Phase I of the study, the primary factors impeding the natural influx of tidal water and drainage of fresh water were identified for each marsh system. General recommendations for improvement are made for each identified factor, with specific recommendations to follow in the Phase II report. The impacts of tidal and stormwater flooding were considered in developing Phase I recommendations. The Phase III report will discuss these impacts in detail.

3.0 FINDINGS - WALLIS SANDS MARSH

3.1 EXISTING DRAINAGE FEATURES

Existing drainage features of the Wallis Sands marshes include the Concord Point outlet, the tidal portions of Parson's and Massacre Creeks, and a network of deteriorated mosquito ditches (Map 1). Points of suspected tidal restriction that were examined for this study are described below.

Culvert numbers correspond to those in "Tasks 2 and 3 Final Report - Summary of Field Investigations of Coastal Wetlands and Associated Road Crossings in the Town of Rye, New Hampshire" (NAI 1986b). Place names follow Simpson (1986).

Concord Point Outlet - This channel provides regular exchange of tidal water for the entire Wallis Sands marsh system. At the Concord Point Bridge the channel measures 39 ft. wide with a bottom profile ranging between 0.96 and 2.91 ft. N.G.V.D. No restriction of tidal flow was observed at the bridge abutment. Minimum water levels in the channel are controlled by bedrock outcrops seaward of the bridge at approximately 2.4 ft. N.G.V.D., or 6.5 ft. above local mean low water (MLW). Previous reports (Simpson 1986, NAI 1986a, NAI 1986b) have indicated that the seaward channel is artificially high due to portions of a sunken barge blocking the natural drainage pathway. The significance of the channel's present configuration to marsh hydrology will be discussed in Section 3.3, Hydrological Analysis.

Culvert #5 - This culvert was the only point along the Massacre Creek drainage that was investigated for tidal restriction. It passes underneath Brackett Road, connecting a small portion of tidal marsh, and the upland Massacre Creek drainage, with the Massacre Creek salt marsh to the east. In general, the Massacre Creek marsh receives good tidal flushing, as evidenced by the relatively lush and even growth of high marsh grasses. Culvert #5 is 30-inch diameter corrugated metal pipe (CMP), approximately 30 ft. long, set at an invert elevation of 3.5 ft. (pipe is level). The culvert appears to be in very good condition and, though set a little high, very functional.

Wallis Road Vicinity - Parson's Creek in the vicinity of Wallis Road is an artificially straightened channel varying in width from 10 to 50 ft. (mostly 10-15 ft.) with bottom elevations at approximately 3.6 ft. N.G.V.D. This channel was probably created when portions of the natural creek route were filled, along with surrounding marsh, to allow construction of Route 1A and adjacent development. Where the creek passes under Wallis Road, the channel measures approximately 8.0 ft wide and 2.5 ft high. The straightened channel extends from north of Old Wallis Road north to the Horse Paddock. Tidal restriction in this area is severe due to several factors, including inadequate channel size, shallows, and the bed of Old Wallis Road which forms a rocky dam at approximately 3.8 ft.

Culverts #3A and #3B - These two culverts connect Parson's Creek with a remnant salt/brackish marsh east of Route 1A about 2.6 acres in size. Both culverts are reinforced concrete pipe (RCP) with an internal diameter of 18 inches. The northern pipe, #3A, is approximately 60 feet in length, with invert elevations of 3.28 ft. (west) and 3.52 ft. (east). Pipe #3B, to the south, is approximately 70 ft. long with invert elevations of 3.85 ft. (west) and 3.92 ft. (east). Both culverts appear to be in good condition. Culvert #3A feeds directly into Parson's Creek and thus has good placement for carrying tidal water from the creek to the remnant marsh. On the east side of the road, culvert #3A feeds into an open channel and pond system which facilitate free exchange of water through the pipe. In contrast, culvert #3B has indirect and only semi-functional connection to Parson's Creek, with limited potential for transmitting tidal water.

Culvert #2 - This culvert connects the northeast section of Parson's Creek marsh to a small brackish marsh (about 6.5 acres) that lies north of Marsh Road. The culvert is 18-inch diameter RCP approximately 40 ft. long. Invert elevations are 3.32 ft. at the culvert's south end and 2.72 ft. at its north end. While the culvert is in good condition, the channels it serves are poorly maintained.

Culvert #1 - This culvert connects the northwest section of Parson's Creek marsh to East Rye Pond which lies north of Marsh Road. The culvert is 18-inch diameter CMP, approximately 40 ft. long, and is functional but showing signs of deterioration at both ends. Invert elevations are 3.95 ft. at the culvert's south end and 4.11 ft. at its north end. Flow in this pipe is non-tidal (unidirectional outflow draining East Rye Pond) except during extreme spring or storm tides.

3.2 TOPOGRAPHICAL SURVEY

Survey data for Phase I at Wallis Sands included determining culvert elevations, road center-lines, and water levels. Water level staffs, placed at suspected points of restriction, were surveyed to correct water level data relative to N.G.V.D. Representative points surveyed on the high marsh surface were between 4.0 and 5.5 ft, with most elevations in the 4.5 to 5.0 ft range. This is the minimum elevation of flooding during spring tides necessary to achieve salt marsh restoration.

The topographical survey of the Wallis Sands marsh will provide the basis for estimating marsh volumes, which will be used to develop specific design criteria for drainage improvements for Phase II, and to determine flood elevations for the impact assessment in Phase III. Ground-truth surveying has been completed, and photogrammetry of existing 1"=1000' aerial photographs is currently in progress. Topographic data are summarized in Appendix 1.

3.3 HYDROLOGICAL ANALYSIS

Water levels, water quality data, and volume flow data (to be used for Phase II) are given in Appendix 3. Stormwater runoff analyses and tidal flood elevations are given in Appendix 2. Results of hydrological analysis of drainage features are discussed in detail below.

The graphs presented in this section show water levels taken on 16 March between approximately 10 a.m. (1000 hrs) and 11 p.m. (2300 hrs). Each plot shows water levels on the upstream side (inside) and downstream side (outside) of a particular culvert or other suspected point of restriction. In addition, selected plots show water levels for the same period at the main tidal outlet or creek for direct comparison. The reader is advised to note that the vertical scale varies from one graph to another in order to best illustrate local conditions. Direct comparisons between graphs should not be made without taking this into account.

Concord Point Outlet - As mentioned earlier, low water levels in the Concord Point channel are controlled by rocky shoals seaward of the Concord Point Bridge. While tidal levels in the ocean regularly fall well below this elevation, resulting in restricted outflow at low tide, this was not found to be the primary factor causing degradation of the salt marsh community. The existing channel is sufficient in cross-section to allow drainage to the level of the shoals, which are approximately 3-4 ft. below the surface of the high marsh. Likewise, during spring (and storm) tides, the Concord Point channel is sufficient to allow flooding of the high marsh surface (ca. 4.5 ft. N.G.V.D.) with incoming seawater (see high tide elevations at Concord Point and Culvert # 5 in Figure 1). The Massacre Creek marsh is a good indication of the adequacy of the Concord Point outlet where, in the absence of internal flow restrictions, the marsh is healthy and well-drained. The present configuration of the outlet is the result of partial removal of the barge in 1985 (Simpson 1986). Complete removal of the barge would greatly improve drainage in Massacre Creek, and the lower part of Parson's Creek marsh. However, restoration of the upper Parson's Creek marsh depends primarily upon the removal of restrictions along Parson's Creek, discussed in detail below.

Culvert #5 - This culvert links the majority of the salt marsh east of Brackett Road with a 1.0 acre salt marsh, grading into fresh marsh and swamp to the west. Figure 1 shows the results of water level measurements taken at both ends of Culvert #5 on 16 March. Water levels correspond closely, except at low tide, when the seaward water level (Level Outside) dropped below the pipe's invert elevation, resulting in a hydraulic drop. While this indicates that the pipe is set higher than would be ideal, the minor restriction of outflow is not adversely affecting the salt marsh community because freshwater retention is low and high tide flooding is unrestricted.

Wallis Road Vicinity - Water levels were monitored in the vicinity of Wallis Road at three stations: 1) Wallis South, located in a wide portion of the channel roughly 400 ft. south of Wallis Road; 2) Wallis Road at the bridge over the creek; and 3) Wallis North, located near the Horse Paddock roughly 350 ft. north of Wallis Road. Water level data indicate continuous restriction of flow along this channel due to inadequate channel dimensions (Figure 2). Debris clogging the channel further restricts flow. Tidal amplitudes for the three stations are as follows:

Station	Tidal Amplitude (Ft.)
Wallis South	0.90
Wallis Road	0.74
Wallis North	0.40

Thus, over a distance of less than 800 feet, the already narrow tidal range at Wallis South (0.90 ft.) is reduced by more than 50 percent.

FIGURE 1

WALLIS SANDS MARSH: CULVERT #5

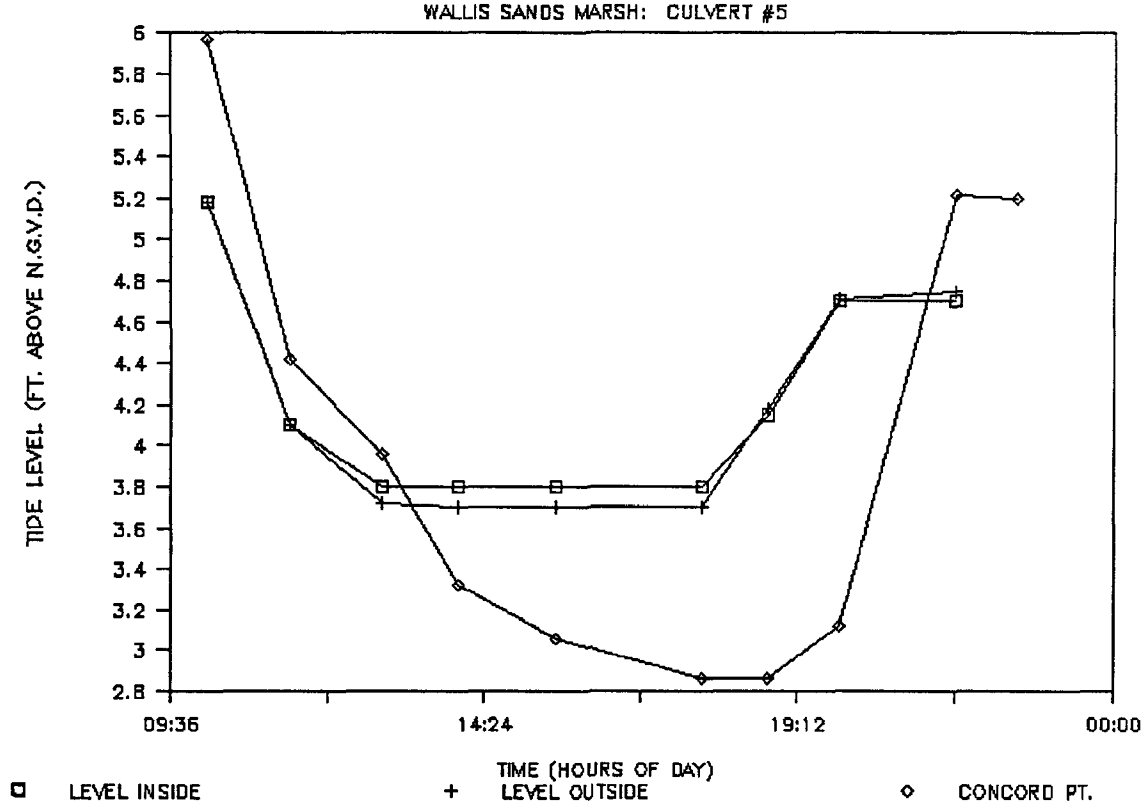
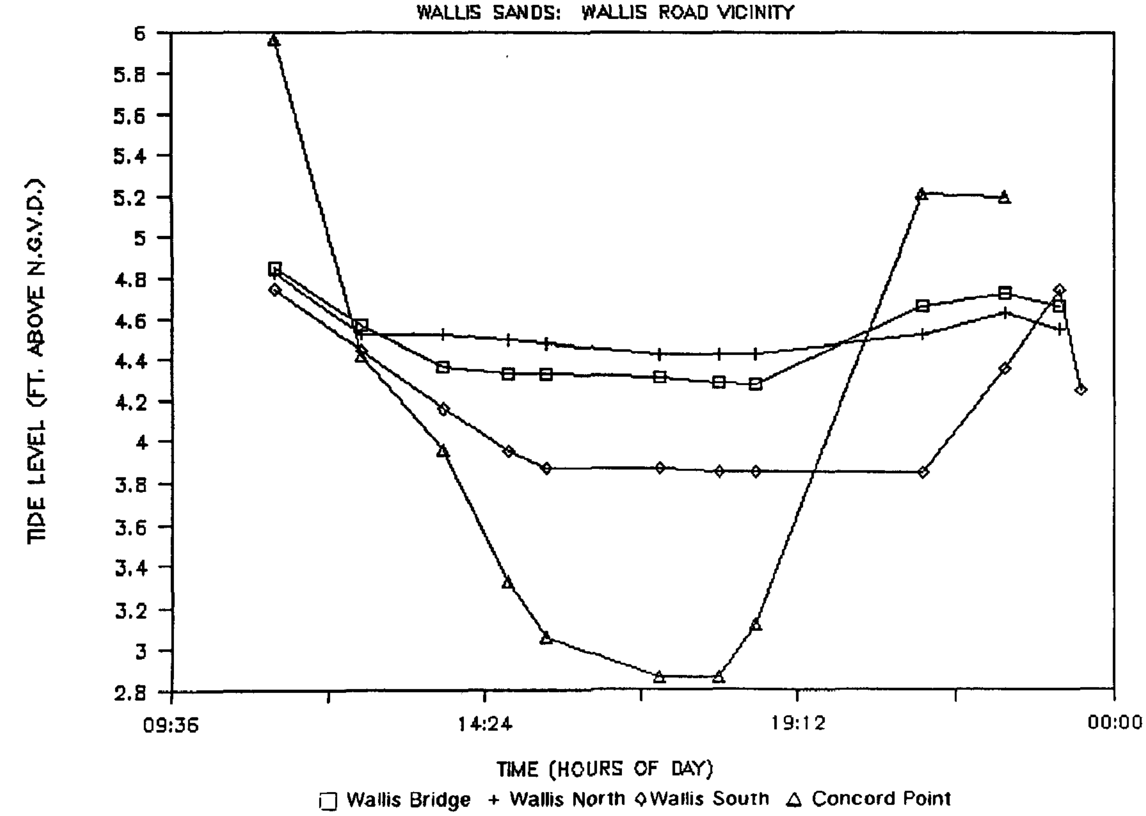


FIGURE 2

WALLIS SANDS: WALLIS ROAD VICINITY



The inadequacy of the tidal creek in this vicinity is compounded by the remnants of the Old Wallis Road roadbed about 300 ft. south of the Wallis South staff. Large stones blocking the creek channel at this point effectively form a dam, the overflow elevation of which is approximately 3.8 ft. Outflow is severely restricted at this point, with water levels below the dam having several times the amplitude observed above the dam. Though no water level staff was placed directly below the dam, the low tide water level was observed to drop approximately 1.5 ft. below dam level, or to approximately 2.3 ft. N.G.V.D., on 16 March. The Old Wallis Road roadbed is the single most restricting feature along Parson's Creek.

Further restriction of flow occurs north of Wallis Road in the vicinity of the Horse Paddock and "trash corner" (Simpson 1986), where a sharp bend in the channel is eroding fill along the bank of an abutter's property. Bank stabilization attempts are evident in the form of boards, cable, and other debris, but are apparently only partially effective. Trash corner is located on the outside curve of a sharp bend and strong currents, especially during outflow, undermine stabilization attempts.

Finally, shallows in the immediate vicinity of Wallis Road cause flow restriction. Bottom elevations at stations north and south of Wallis Road are 0.5 to 1.0 ft below the invert elevation of 3.6 ft N.G.V.D. at the Wallis Road bridge. These depth changes slow both inflow and outflow.

<u>Culverts #3A and #3B</u> - Tidal flow between Parson's Creek and the remnant marsh is restricted by undersized pipes and an insufficient channel linking culvert #3B to the creek. Tidal fluctuation in this section of Parson's Creek is minimal - measurements during the sample period had an amplitude of 0.30 ft. at the west end of culvert #3A. In the remnant marsh east of Route 1A, water levels fluctuated 0.12 ft. at

culvert #3A and 0.10 ft. at culvert #3B (Figure 3). Most of the volume exchange between Parson's Creek and the remnant marsh occurred via culvert #3A (see Appendix 3). The superior functioning of culvert #3A results from its direct connection from Parson's Creek to open water in the remnant marsh. In contrast, culvert #3B connects to Parson's Creek via approximately 160 ft. of narrow ditch that results in flow restriction.

Culvert #2 - Although this culvert is in good condition and functional, very little flow was observed during the survey period. Water levels on either end of the culvert remained nearly constant, and essentially equal (Figure 4). Tidal flow in and out of the small brackish marsh north of Marsh Road is restricted mainly by the lack of a functional channel between culvert #2 and Parson's Creek. Flow between the creek and the culvert must pass through dense vegetation and shallow ditches, and thus shows little response to tide levels. The culvert itself readily equalizes changes in water level, which are due mainly to freshwater streamflow and runoff from the north. Water levels in this vicinity were 0.3-0.5 ft. above levels in Parson's Creek due to flow restriction between the culvert and the creek.

Culvert #1 - This culvert is essentially beyond the reach of regular tidal fluctuation for two reasons. Tidal inflow via Parson's Creek is restricted by artificial obstructions (previously discussed), and by the creek's natural configuration. In addition, the small size of culvert #1 restricts freshwater outflow, resulting in a freshwater/brackish pond (East Rye Pond) that drains continuously into the marsh. Outflow from East Rye Pond was continuous during the sample period, and the water levels inside the pond remained essentially constant (Figure 5). South of the culvert, water levels showed a minor response to tide levels (amplitude = 0.09 ft.), but not enough to reverse flow.

FIGURE 3

WALLIS SANDS: CULVERTS #3A AND #3B

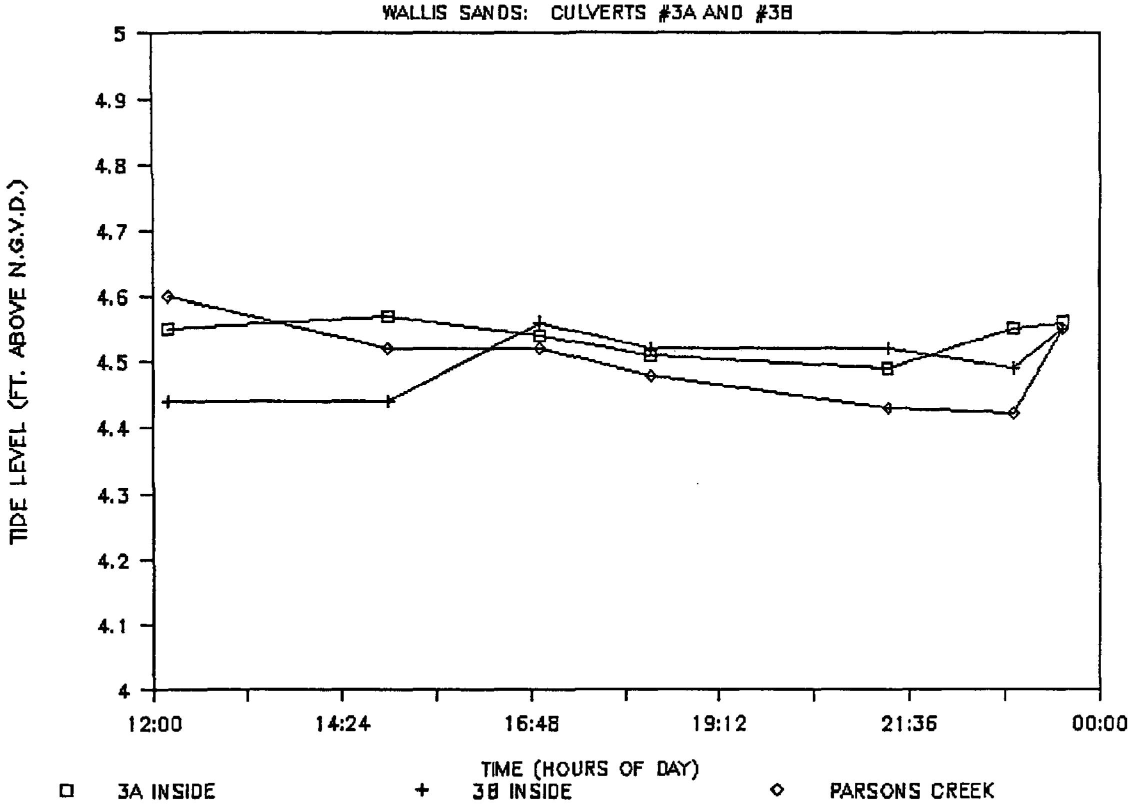


FIGURE 4

WALLIS SANDS MARSH: CULVERT #2

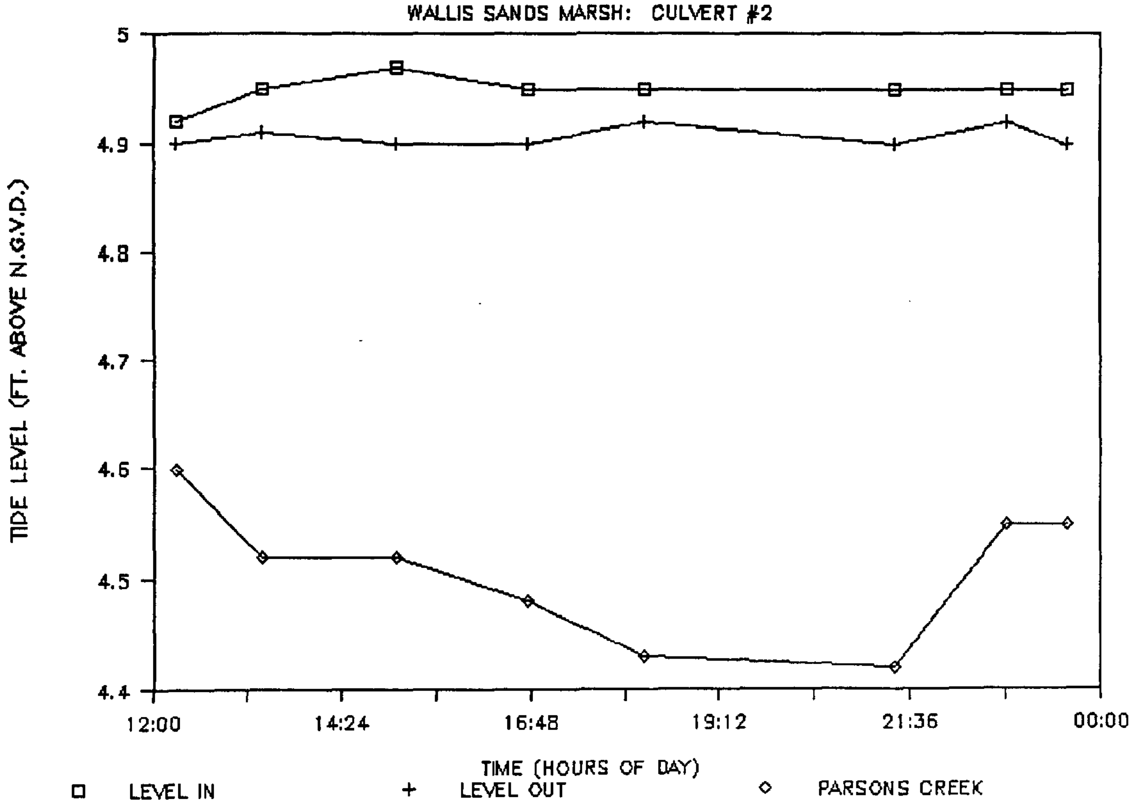
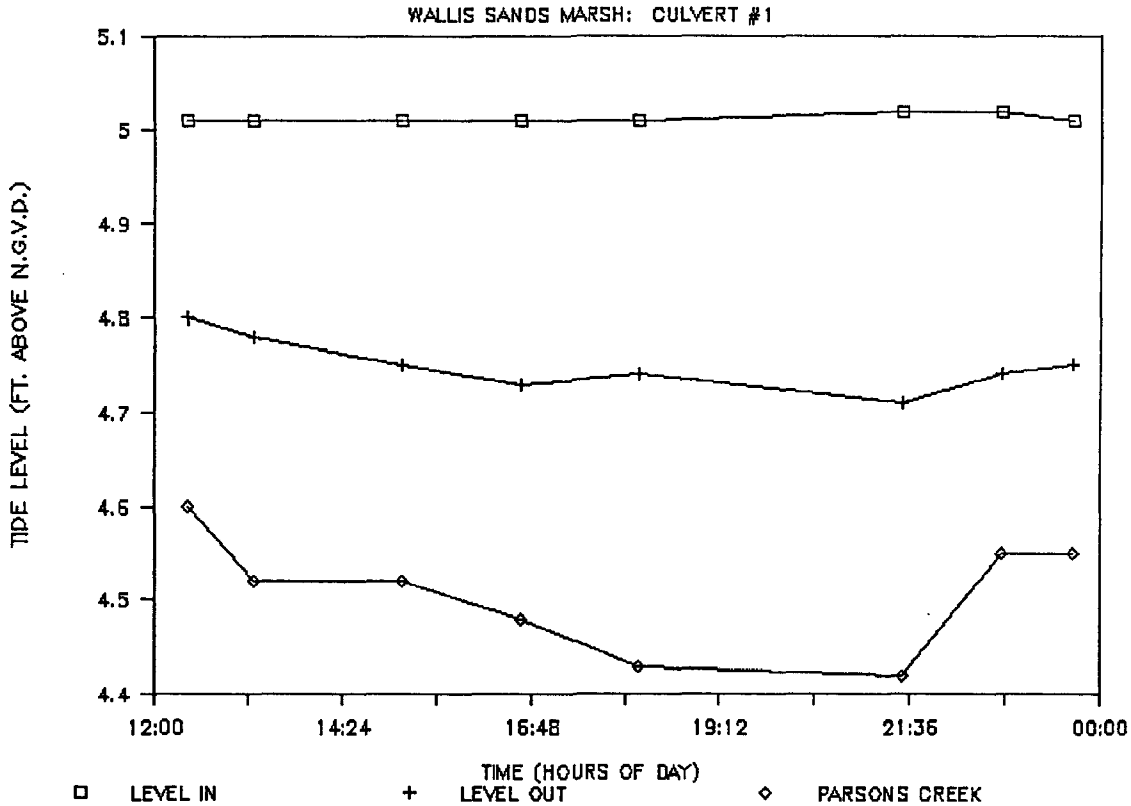


FIGURE 5


WALLIS SANDS MARSH: CULVERT #1
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
TIDE LEVEL (FT. ABOVE N.G.V.D.)
12:00
14:24
16:48
19:12
21:36
00:00
TIME (HOURS OF DAY)
LEVEL IN
LEVEL OUT
PARSONS CREEK

3.4 WALLIS SANDS RESTORATION NEEDS - CONCEPTUAL

Existing impediments to tidal flows in the Wallis Sands marshes result almost exclusively from recent and historical road crossings on the marsh. Tidal flow is restricted when the tidal head in the channel exceeds the capacity of the culverts installed, or when culverts are set above grade, resulting in a hydraulic jump. During spring tides, which flood the high marsh surface, tidal restriction is made worse by the diking effect of the roadbed. Sheet flow across the marsh surface is thus blocked, and the additional water must be able to pass through the culvert to ensure normal flooding of the marsh landward of the pipe (Clark 1977). Roadbeds also restrict subsurface flow by compacting marsh peat. While generally very minor, this can result in impeded drainage and percolation of surface water (Hemond *et al.* 1984).

Recommended drainage improvements to increase tidal circulation in the Wallis Sands marsh focus on the removal of obstructions along the main channel of Parson's Creek in the vicinity of Wallis Road. Second in priority is improvement of the tidal channel at Concord Point, although this may not be an option for reasons discussed in Simpson (1986). Improvements to culverts and ditches that connect Parson's Creek to small marshes isolated by road crossings are also recommended. Though less critical to the overall restoration process, improved drainage of the small peripheral marshes will increase stormwater runoff capacity during flood events.

These recommendations are conceptual, and generally follow the findings of "Tasks 2 and 3 Final Report - Summary of Field Investigations of Coastal Wetlands and Associated Road Crossings in the Town of Rye, New Hampshire" (NAI 1986b). These recommendations are based on detailed investigations of site-specific hydrology and topography, and will be followed by specific design recommendations in the Phase II report.

Parson's Creek - Removal of obstructions and channel enlargement are recommended from the Old Wallis Road roadbed north to the vicinity of the Horse Paddock. Highest priority should be given to the Old Wallis Road roadbed, which should be removed from the creek, with the channel improved to conform with surrounding dimensions. Shallows in the vicinity of Wallis Road are also recommended for dredging to an elevation of approximately 2.5 ft. N.G.V.D. (1.0 ft. below existing grade). Reconfiguration of the channel at the sharp bend south of the Horse Paddock, known as trash corner, is recommended to increase flow and alleviate channel erosion problems. Channel reconfiguration alternatives may include widening the existing channel and stabilizing the creekbank, or straightening the channel by relocating it further west. The exact extent of recommended channel modifications in the vicinity of Wallis Road will be determined during Phase II of the study, in consultation with Town officials.

Concord Point Outlet - Restoration of the Concord Point outlet channel to pre-barge dimensions is recommended for improving tidal flushing of the marsh. The political and biological aspects of this action are discussed at length in Simpson (1986). Detailed review of the engineering of the dredging project is beyond the scope of this study.

Culverts #3A and #3B - Replacement of culvert #3A with a drainage structure of roughly twice the capacity, and improvement of drainage ditches at both ends of culvert #3B are recommended. Self-regulating tide gates are recommended to reduce the hazard of storm surge flooding. These structures are designed to allow free passage of tidal waters during normal tidal cycles. During extreme flood tides, a one-way valve closes over the culvert mouth, thus preventing inflow beyond flood levels. At low tide the valve allows free outflow to drain flood waters, and can be reset manually to allow free-flow (T. Steinke, Town of Fairfield, CT, Conservation Commission, personal communication).

Culvert #2 - Improvement of drainage ditches and channels south of culvert #2 is recommended. A self-regulating tide gate, to protect against flooding due to tidal storm surge, is recommended for installation at the south end of the pipe.

Culvert #1 - Previous reports have noted that the East Rye Pond area was formerly a high salt marsh community (Simpson 1986, NAI 1986b), that has gradually been converted to a brackish pond by freshwater retention and tidal restriction. Although the present ecological community is artificial in this respect, locally it is relatively rare compared with salt marsh. East Rye Pond provides open water habitat for waterfowl, as well as providing additional habitat diversity for wetland-dependent wildlife. In addition, the pond adds aesthetic value to the area. Complete tidal restoration of East Rye Pond would result in loss of the brackish pond community and its associated values. Therefore, we recommend that East Rye Pond be maintained as a brackish pond, with drainage improvements made to reduce flooding due to stormwater runoff.

Replacement of the existing culvert with larger capacity drainage structures is recommended to improve stormwater runoff. Replacement structures can be set at the approximate elevation of the existing culvert to maintain open water in East Rye Pond, while allowing for rapid passage of overflow during storm events. The low elevation of Marsh Road in this vicinity limits drainage and flood control options, and will be a consideration in designing specific recommendations in Phase II.

Culvert #5 - There is no immediate need to replace this culvert for tidal restoration purposes. In the normal course of maintenance, it is recommended that a replacement structure of similar size be set approximately 0.5 ft. below the invert of the existing culvert.

4.0 RESULTS - PHILBRICK BROOK MARSH

4.1 EXISTING DRAINAGE FEATURES

Existing drainage features of the Philbrick Brook marsh include the Rye Harbor outlet, an expansive network of tidal channels and mosquito ditches, and several drainage structures under road crossings (Map 2). Points of suspected tidal restriction that were examined for this study are described below. Elevations are given relative to N.G.V.D., as discussed in Section 3.1.

Rye Harbor Outlet - This channel provides tidal exchange for the entire Philbrick Brook marsh system. At the Harbor Road Bridge, the channel measures 19 ft. wide with a rocky, irregular bottom. Measurements of bottom elevations ranged between -2.40 ft. and -0.60 ft. Minor restriction of flow was observed at the bridge abutment, which appears to be in very good condition. Minimum water levels in the channel are controlled by stony-gravelly shoals seaward of the bridge at approximately -1.5 ft., or 2.6 ft. above MLW.

Culvert #7 - This culvert connects the main portion of the tidal marsh with a semi-isolated marsh west of Route 1A just south of the Harbor Road junction. The pipe is 24-inch diameter CMP in good condition, set at invert elevations of -0.44 ft. (east) and -0.57 ft. (west). The network of ditches west of this pipe is showing signs of slumping and deterioration, as described in NAI (1986b).

Culvert #8 - This drainage structure is a sluiceway constructed of granite blocks that passes under Route 1A approximately 850 ft. south of culvert #7. The granite sides of the sluiceway appear to be in good condition, however, the overlying concrete slab is severely deteriorated particularly at the east end. The channel measures approximately 40 inches wide, with a rocky, irregular bottom at about 2.37 ft. The bottom is elevated at this point relative to the Rye Harbor outlet due to rocky shoals about 200 ft. downstream of the sluiceway. These rocks may be mostly of natural origin, but many appear to have spilled over the embankment during the filling of adjacent marsh for construction of a hotel. This channel is the primary drainage for Philbrick Brook marshes west of Route 1A.

Several old stone walls criss-cross the marsh surface upstream of culverts #7 and #8. The remnants of salt marsh pasturing practices, these walls have sunken several feet into the marsh peat. Although they do not directly interfere with tidal exchange in the main drainage channels, their deleterious effect on surface water drainage and infiltration is apparent. They will be discussed further in Section 4.3, Hydrological Analysis.

Culvert 9 - This 36-inch CMP hydraulically connects salt marshes on either side of Locke Road, and is situated upstream of culvert #8 in the primary Philbrick Brook drainage. The pipe, though set too high, appears to be in very good condition with invert elevations of 2.39 ft. (north) and 2.87 ft. (south). The pipe is set in a granite stone abutment.

Culvert #10 - This 30-inch CMP passes under a private drive just south of culvert #9 along the main Philbrick Brook channel. Invert elevations are 2.98 ft. (north) and 2.97 ft. (south). The pipe appears to be in very good condition.

Culvert #11 - This culvert is located south of the junction of Locke Road and Route 1A, and north of the junction of Atlantic Avenue and Route 1A. This culvert connects the main branch of Philbrick Brook salt marsh to a small, isolated brackish marsh (ca. 4.2 acres) east of Route 1A. The culvert is 18-inch diameter CMP that is corroded, partially collapsed, and partially clogged with sediment. Invert elevations are 4.37 ft. (west) and 4.22 ft. (east). The west invert is set well above the tidal channel, thus limiting tidal flooding. The pipe's deteriorated condition and high elevation also restrict outflow from the isolated marsh.

4.2 TOPOGRAPHICAL SURVEY

As with the Wallis Sands marsh, survey data for Phase I at Philbrick Brook included determining culvert elevations, road center-lines, and water levels. Water level staffs, placed at suspected points of restriction, were surveyed to correct water level data relative to N.G.V.D.

The topographical survey of the Philbrick Brook marsh will provide the basis for estimating marsh volumes, which will be used to develop specific design criteria for drainage improvements for Phase II, and to determine flood elevations for the impact assessment in Phase III. Ground-truth surveying has been completed, and photogrammetry of existing 1"=1000' aerial photographs is currently in progress. Topographic and photogrammetric work completed or in progress is summarized in Appendix 1.

4.3 HYDROLOGICAL ANALYSIS

A conspicuous feature of the Philbrick Brook marshes are the large tide pools, or pannes, that occupy the marsh surface. These areas are shallow, unvegetated pools that retain flood and rainwater, and dry out during dry periods. Pannes are a natural feature of New England high salt marshes, and their origin and ecology are only partly understood. While their distribution relates to poor surface drainage, they do not necessarily indicate an unhealthy marsh, and in fact may increase a marsh's value for water-dependent wildlife. For this study, pannes were considered "negative" features when their origin was obviously the result of human disturbances. In such cases, recommendations will be made for drainage improvements in the following section. If desirable, natural pannes, or those of questionable origin, may be managed using methods similar to those we recommend for disturbed areas.

Hydrological analysis of the Philbrick Brook marsh is based on a 14-hour sampling period on 16 March 1988, as outlined in Section 3.3. Sampling data are presented in Appendix 3. Stormwater runoff analyses and tidal flood elevations are given in Appendix 2. Results of the analysis are discussed in detail below.

Rye Harbor Outlet - Low water levels at the Rye Harbor outlet are controlled by rocky-gravelly shoals seaward of the Harbor Road Bridge at approximately -1.5 ft., or 2.6 ft. above local MLW. Although tide levels in the ocean regularly fall below this level, the channel's present configuration was not found to be restricting tidal flushing of the marsh system. Water levels at the bridge are shown in Figures 6 and 7. The tidal amplitude observed at this station on 16 March was 7.45 ft. Tidal channels upstream of the bridge drained to near-minimum levels during low tide, indicating adequate drainage. Similarly, high tide levels were adequate to flood the marsh surface.

Despite good drainage in the main tidal channel, large areas of the marsh surface show evidence of poor drainage. Broad pannes have formed behind old stone walls that criss-cross the marsh in several places. These walls act as dams, preventing drainage of surface water. In addition, the walls compact the underlying peat layer, thus impeding infiltration and subsurface flow. Water from tidal flooding and rainfall remains ponded on the marsh surface for excessive periods, resulting in vegetation die-off, breakdown of the peat, and erosion. Large panne areas are especially prevalent in the southern half of the marsh south of Rye Harbor.

Culvert #7 - Water levels measured at culvert #7 are shown in Figure 6. Close tracking of water levels on both sides of the pipe indicate that there is no restriction of flow through the existing channel. The marsh area west of Culvert #7 suffers from the effects of old stone walls and poor infiltration as described above. Unvegetated pannes have formed behind old walls, and peat slumping and erosion are prevalent.

Culvert #8 - Water levels from 16 March indicate good tidal flooding through the granite sluiceway. Minor restriction of outflow, shown in Figure 7, is caused by a higher bottom elevation at the sluiceway's landward end. Figure 7 also shows water levels at the Rye Harbor outlet, which drop several feet below culvert #8 at low tide. This is the result of the increasing elevation of the channel east of culvert #8. Whether this shoaling is of natural origin or the result of fill is not known at this time. Nonetheless, channel elevations are sufficiently low to permit adequate drainage during outflow.

The marsh between culverts #8 and #9 is criss-crossed with old stone walls which, as discussed in the previous paragraphs, result in prolonged surface ponding. Large areas have been flooded and remain unvegetated. The surface peat layer has deteriorated and eroded, and in many spots has broken through to form deep holes. Remnant walls parallel both sides of the creek in this area, and others occur between the creek and the upland edge.

Culvert #9 - This culvert was found to restrict outflow due to improper placement. Figure 8 shows water levels on both sides of the pipe during sampling on 16 March. The pipe's size is sufficient to allow flood tides to enter the marsh, but does not allow adequate drainage because it is set above the grade of the creek bed. Low tide water levels on the upstream side of the pipe remained approximately 1.0 ft. higher than the downstream side. Elevated water levels prevent peat

FIGURE 6

PHILBRICK BROOK MARSH: CULVERT #7

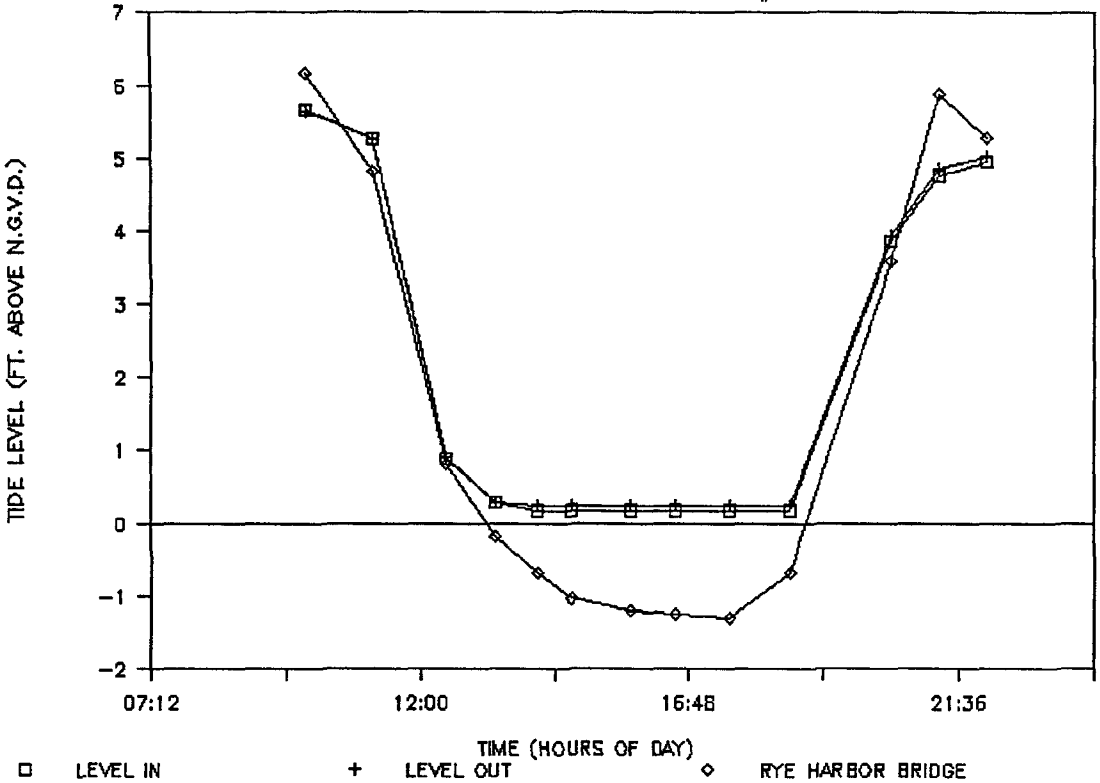


FIGURE 7

PHILBRICK BROOK MARSH: CULVERT #8

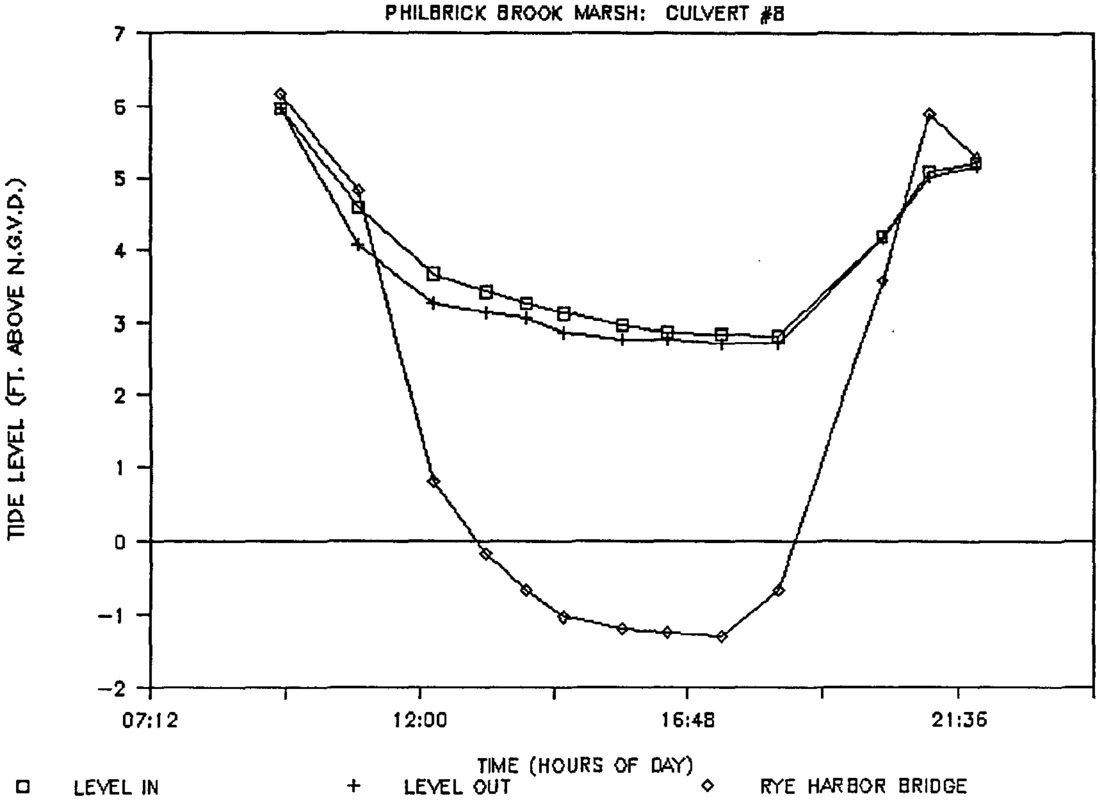


FIGURE 8

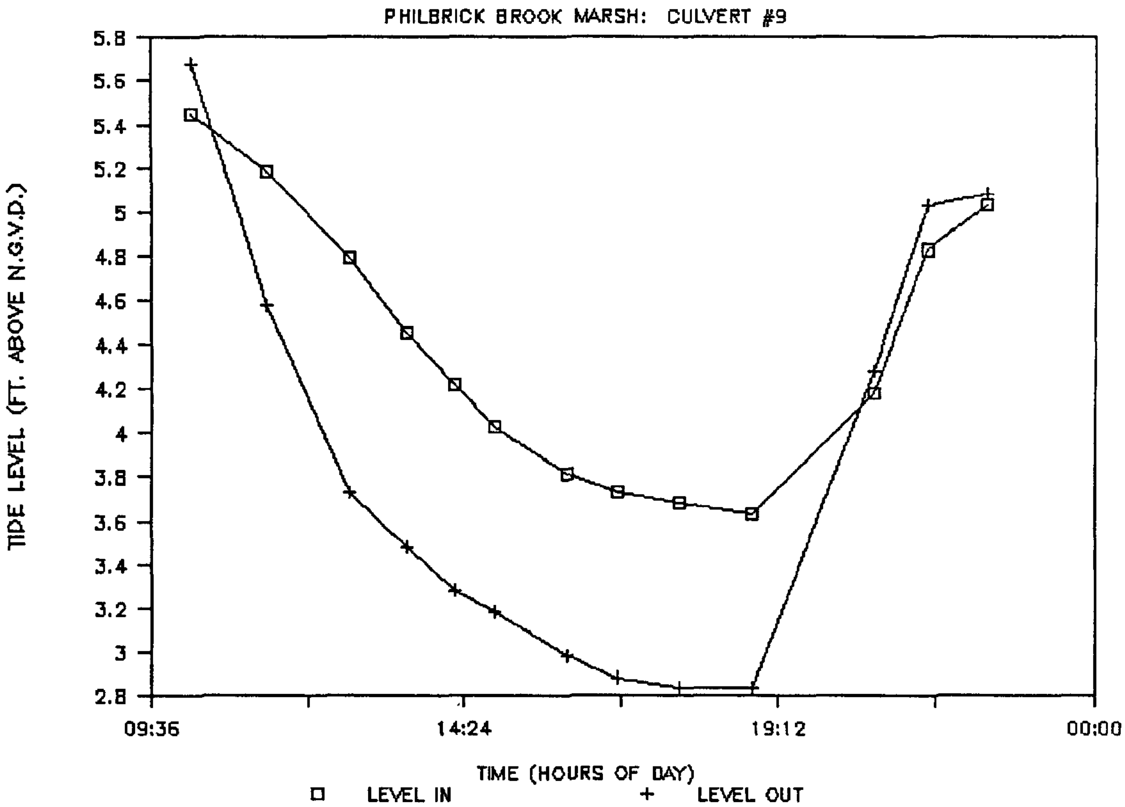
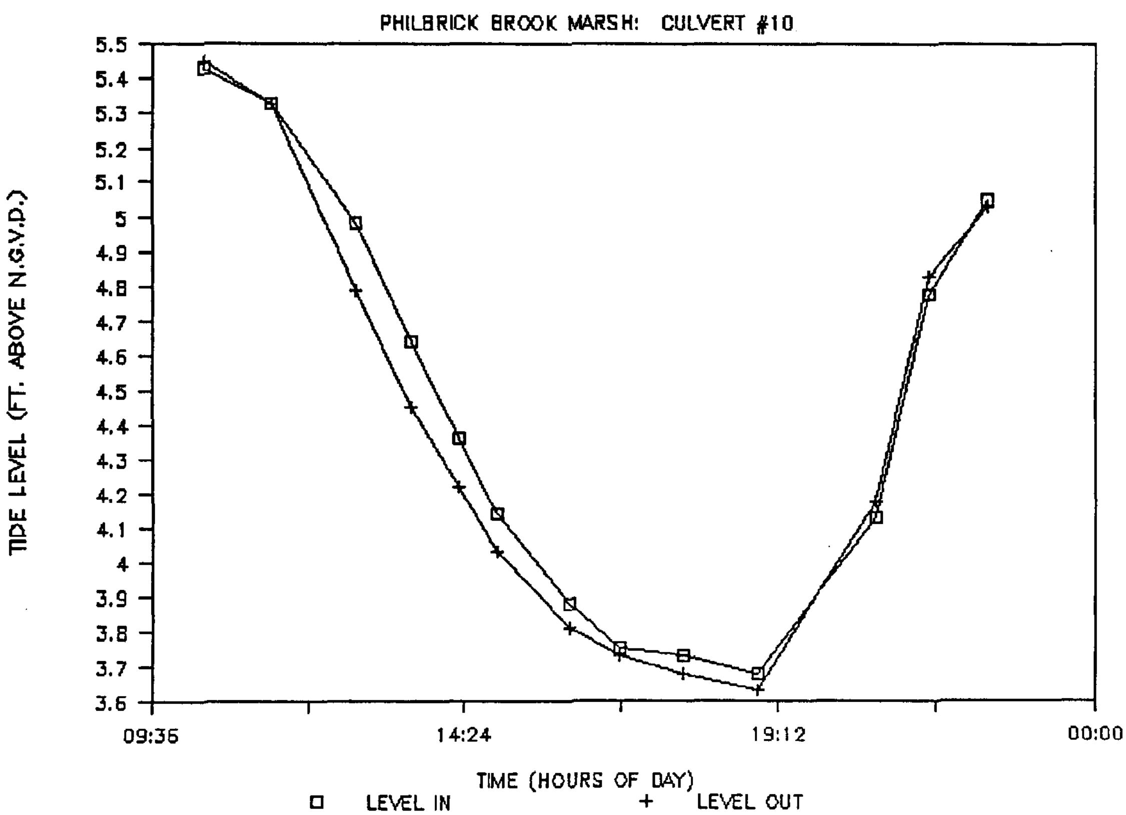


FIGURE 9

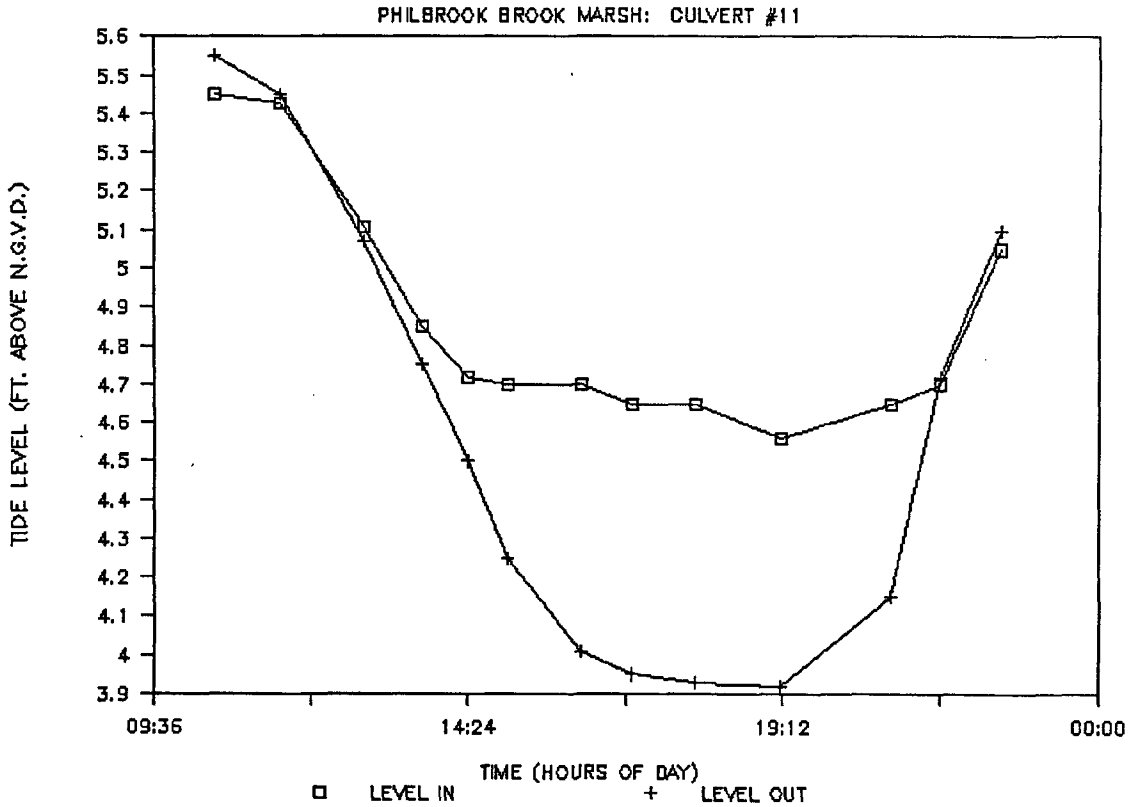


drainage, resulting in water-logging and vegetation die-off. The effects of outflow restriction can best be seen in the marsh area upstream of culvert #10, where the peat surface is deteriorating and pannes are forming.

Culvert #10 - Figure 9 illustrates relatively free exchange of tidal flow through culvert #10. This culvert is slightly undersized for the channel it serves, and minor restriction of outflow was observed during the sample period. Outflow water levels were elevated approximately 0.1 ft. upstream of the pipe compared with downstream levels.

Culvert #11 - This culvert severely restricts tidal exchange between the brackish marsh east of Route 1A and Philbrick Brook. Water levels on both sides of the culvert are shown in Figure 10. At the end of the flood tide period, water levels in Philbrick Brook measured 0.1 ft. higher than in the isolated marsh, indicating moderately restricted flow. Severe restriction of outflow is caused by the pipe's high setting and deteriorated condition, and resulted in water levels in the brackish marsh being elevated by approximately 0.7 ft. during low tide.

FIGURE 10


PHILBROOK BROOK MARSH: CULVERT #11
TIDE LEVEL (FT. ABOVE N.G.V.D.)
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
09:36
14:24
19:12
00:00
TIME (HOURS OF DAY)
LEVEL IN
LEVEL OUT

4.4 PHILBRICK BROOK RESTORATION NEEDS - CONCEPTUAL

Rye Harbor Outlet - Maintain channel in present configuration or larger. In marsh areas that have been cut-off by old stone walls, extend ditches from tidal creeks into panne areas to restore natural drainage and encourage revegetation.

Culvert #7 - Maintain present culvert and creek channel. Improve and extend creek and ditches to the west, cutting through old stone walls to restore natural drainage of surface water and encourage revegetation.

Culvert #8 - Repair deteriorating sluiceway, especially at east end where collapse is imminent and potentially hazardous. Breach old stone walls on both sides of the creek upstream of culvert #8. Extend ditches through breached walls to restore natural drainage and encourage revegetation.

Culvert #9 - Replace existing culvert with drainage structure of similar capacity set approximately 1.0 ft. below the present invert elevation to improve outflow and maintain inflow capability.

Culvert #10 - Replace existing structure with slightly larger structure set at present elevation.

Culvert #11 - Replace existing culvert with larger capacity pipe set approximately 1.5 ft. below the present invert elevation to improve outflow and inflow capacity. Install a self-regulating tide gate on the pipe's western end to protect against flooding due to tidal storm surge.

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APPENDIX 1

TOPOGRAPHIC DATA SUMMARY

1. Report of Survey
2. Data Printout

BV Pearson-Associates, Inc.
Consulting Engineers and Land Surveyors
P.O. Box 280, Chester, N.H. 03036
REPORT OF SURVEY

April 6, 1988

Mr. Dave Cowan
Normandeau Associates, Inc.
#25 Nashua Road
Bedford, N.H. 03102-5999

re: Job #1600,
Survey of Lands on Route 1-A, Rye, NH

Dear Dave:
The following is the **Report of Survey** for both parcels of Marshland located on Route 1-A in Rye, New Hampshire as shown on our worksheet plans dated April 5, 1988 enclosed with this report.

RESEARCH

In preparation for the field work on this job, we researched our files and contacted the New Hampshire Department of Transportation to ascertain what Vertical Control monumentation might be in the area and have located some monuments in the vicinity of the jobs that may be used to tie to precise USGS elevation datum if deemed necessary in the future.

FIELD WORK

On March 31 and April 1, 1988 we performed the field topographic surveys using a Topcon Electronic Theodolite survey system using two of your employees (yourself and Connie Delano) as rodmen. The field work for each site is as follows:

Rye Harbor (South) site

We conducted an open-ended traverse of 6 stations, tying in to an old and unreliable USC&GS monument near Station #503 which has been used as published for our elevation datum at this point in time. Our level loop run from Station #501 to #506 and back resulted in an error of 0.06' vertical which was balanced out between stations and we also ran a level line to the east from Station #501 to two shots approximately 500 feet east of Station #501. The assumed elevation at H-32 agreed substantially with your elevation reference at the culvert at Locke Road, and as we have discussed should be close enough for your work at this point in time.

Cont.

Wallis Sands (North) site

We conducted a traverse of 9 stations, partly open and partly looped (see Dwg. #1600-902) from the bridge near Rye Harbor north past Wallis Road to Parsons Road and Brackett Road and back across the marsh to Station #603 near Wallis Road. The elevation assumption for this traverse was one you provided at the Wallis Road Bridge centerline as discussed, and that elevation checked out substantially with your other given elevation at the culvert at Parsons Road to the north. The vertical loop closure around the northerly 6 stations resulted in no error as recorded, so no adjustment was needed. The elevations south from Station #603 are not in that loop and are computed by turning point only. The horizontal math check on the northerly loop stations resulted in an error of 0.02', so no adjustment was made on that data either, and the southerly stations are again open ended.

CONCLUSIONS

The data given on the enclosed coordinate and elevation printout is based on the above assumptions, but the apparent precision of the work and the cross-checking of known elevations appear to bear out that the elevations and locations are reasonably accurate and should be suitable for your intended purpose at this point in time.

Please note that there is some horizontal distortion of the points on the Bluline prints due to reproduction procedures, and if you need a precise printout of data points, let us know and we can forward a copy directly from the plotter. With the enclosed coordinate list you can also inverse between any desired points and determine precise orientations.

RECOMMENDATIONS

Depending on the results of your further study and analysis, verification of our data to established precise elevations in the field may be needed or if there are any additional data points that you need to recover that we were unable to get due to time or distance constraints, please let us know at your earliest convenience to arrange that work.

Enclosed is a statement for our services for the work on these lots. If you have any questions on the above, please contact us at your convenience.

Sincerely yours,

Chas Pearson

Chas Pearson, President,
B. V. Pearson Assoc, Inc.

THE STATE OF NEW HAMPSHIRE
CHAS R. PEARSON
No. 2237
REGISTERED PROFESSIONAL ENGINEER

COMMAND 212-

Job # 1600

Normandeau Assoc. Inc

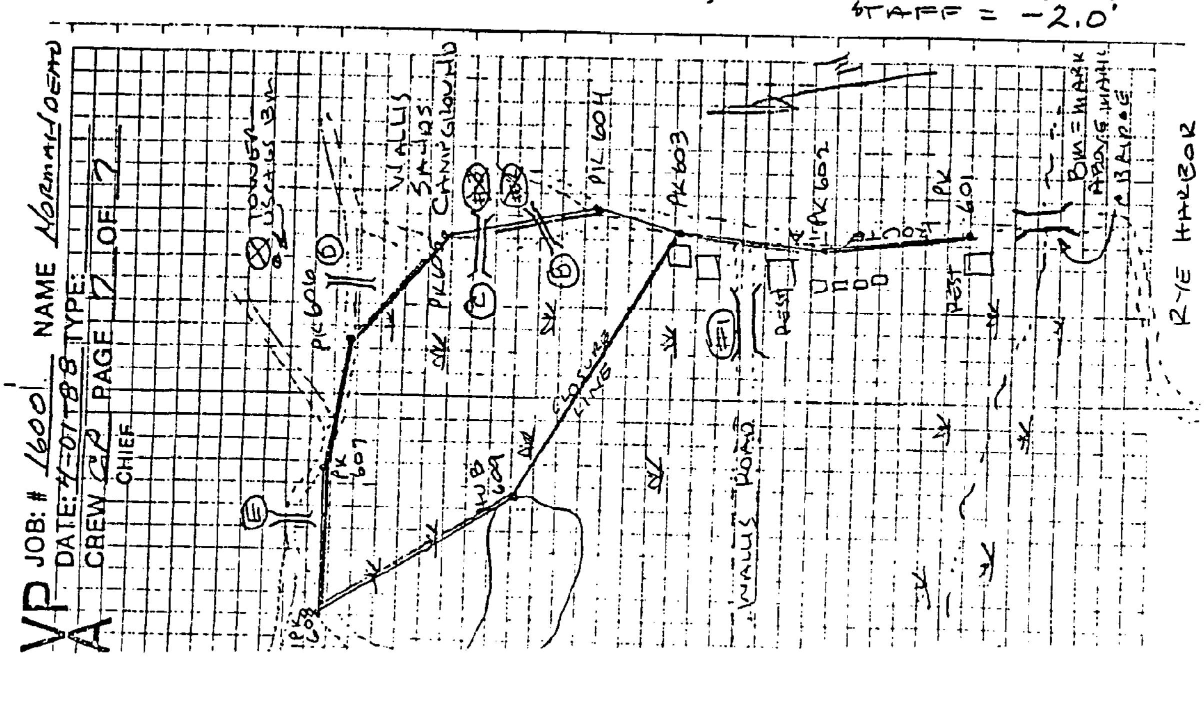
TOPO COORDINATE 3x1 PRINTOUT FOR SITE AT Wallis Sands, Rye, N.H. TO BE USED WITH BVPINC PLAN # 1600-902

4-05-88

Chas Pecora

ELEVATION		POINT #	NORTHING	EASTING	
4.03	WALLIS SOUTH	1	6545.6675	5002.9158	STAFF 0.8'
4.30	CULV "B" WEST	2	8007.1024	6274.0961	STAFF = 0.8'
12.76	BRIDGE ABUTMENT	201	4830.6996	4960.9139	
12.40	℄ PVMT @ BRIDGE	202	4840.9781	4965.9941	
4.12	WALLIS BRIDGE	203	6742.1084	5346.3431	WATER LEVEL = 0.1'
~~2.61~~	" " BOTTOM	204	6741.1975	5347.6477	
7.59	" " ROAD ℄	205	6729.5318	5337.5668	
4.23	" NORTH STAFF	206	7017.0877	5466.2563	LEVEL = 1.6'
3.85	INVERT "B" WEST	207	8003.5504	6424.5882	
3.91	" "B" EAST	208	7981.2494	6502.7106	@ "B"
4.38	STAFF "B" EAST	209	7977.7601	6504.3674	LEVEL = 0.7
9.92	℄ RD @ CULV "B"	210	7992.6966	6462.9440	
4.26	CULV "C" EAST	211	8306.0355	6599.7313	WAT LEVEL STAFF = 1.21'
3.52	CULV "C" INVERT EAST	212	8311.8917	6596.2670	
3.28	CULV "C" " WEST	213	8344.9732	6531.0388	
4.34	" " WEST LEVEL	214	8345.5649	6531.6164	STAFF = 2.20'
8.73	℄ ROAD @ "C"	215	8330.4232	6567.0232	
2.72	CULV "D" NORTH INVERT	216	9131.1457	7214.8755	
4.87	CULV "D" North Level	217	9131.9516	7211.6159	STAFF = 1.2'
6.49	℄ ROAD @ "D"	218	9123.5781	7197.6171	
3.32	CULV. "D" South INVERT	219	9112.2659	7182.6270	
5.00	"D" South Water Level	220	9112.8937	7183.1867	STAFF = 0.8'
4.64	MARSH SURFACE	221	9277.7404	7051.2415	NEAR ROAD
4.11	CULV "E" North INVERT	222	10469.1831	6497.6918	
5.13	" " N. WATER LEVEL	223	10482.7972	6491.2396	STAFF = 1.6'
7.03	℄ RD. @ CULV "E"	224	10452.1201	6454.0331	
3.95	CULV "E" South INVERT	225	10444.3202	6465.2883	
4.74	" " WATER LEVEL	226	10437.7300	6460.9946	STAFF = 1.04'
3.50	"F" EAST INVERT	227	5503.8586	2425.0560	
10.02	STATIONS	601	5000.0000	5000.0000	ASSUMED COORDS
8.75		[illegible]	6429.3707	5377.3649	
7.88		603	6914.1104	57[illegible]	
10.29		604	7691.5905	6390.4077	
9.05		605	8470.7834	6701.4932	
6.45		606	9346.6366	7043.8085	
15.47		607	9922.9876	6664.9554	
9.38		608	10617.6157	6262.7457	
5.05		609	9312.7358	6222.6222	
		610	6914.1069	5735.9464	

COULD NOT READ LAST SHOT DUE TO RAIN, NOTE WAS CULVERT F WATER LEVEL, STAFF = -2.0'



COMMAND 212-

JOB# 1600
NORMANDEAU ASSOC
TOPO COORD PRINTOUT
FOR SITE IN RYE, N.H.
SOUTH OF RYE HARBOR
TO BE USED WITH
BVPINC PLAN 1600-901

4-05-88
Chas Pean

	ELEVATION		POINT #	NORTHING	EASTING	
	3.33	MARSH	1	4781.1492	5154.6366	
	5.06	EDGE	2	4781.8667	5044.4458	
	4.58	BOTTOM	3	4774.6247	5040.6078	
	5.02	EDGE	4	4768.6188	5036.4747	
	4.53	EDGE	5	4823.0004	4990.8787	
	2.99	BOTTOM	6	4825.1479	4988.2330	
	4.78	EDGE	7	4831.0890	4983.4629	
	4.65	EDGE	8	4678.7599	4984.1014	
	2.30	BOTTOM	9	4675.0923	4979.7488	
	4.66	EDGE	10	4671.8864	4975.3930	
	4.87	BOTTOM	11	4619.3391	5010.5589	
	4.14	EDGE	12	4747.0741	4841.4423	
	0.09	BOTTOM	13	4746.6280	4845.4422	
	4.43	EDGE	14	4747.6427	4852.9771	
	3.03	SURFACE	15	4749.8265	4873.0197	
	4.78	EDGE	16	4575.3214	4668.4690	
	3.24	BOTTOM	17	4572.5362	4663.8204	
	4.66	EDGE	18	4563.6541	4637.6903	
	4.67	EDGE	19	5030.9288	4876.3525	
	3.51	BOTTOM	20	5029.6373	4876.4992	
	4.76	EDGE	21	5026.5794	4877.0655	
	4.78	EDGE	22	4935.9345	4742.9410	
	2.95	BOTTOM	23	4911.9640	4753.3717	
	4.72	EDGE	24	4887.9211	4791.0954	
	4.15	EDGE	25	4847.3056	4352.2838	
	2.10	BOTTOM	26	4849.5728	4351.2673	
	4.00	EDGE	27	4852.8909	4349.5046	
	3.49	EDGE	28	4651.1364	4391.8892	
	1.46	BOTTOM	29	4651.9573	4389.7073	
	3.42	EDGE	30	4652.8436	4387.6256	
	4.77	SURFACE	31	4658.0816	4343.8615	NOT YOU FLAG #3
"A" STAFF READING = 3.50' →	3.15	ELEV WATER @ "A"	32	4812.5881	4281.7152	← SEE PT #107 ↓
	1.64	BOTTOM	33	4942.9441	4150.5994	
	4.60	EDGE	34	4946.4548	4150.9638	
	3.01	BOTTOM	35	5110.9502	4194.9976	
	4.85	EDGE	36	5111.2422	4192.8037	
	5.32	EDGE	37	5145.6122	4270.2421	
	4.73	BOTTOM	38	5148.8779	4269.2029	
	4.38	EDGE	39	4301.5669	3619.2895	
	5.34	SURFACE	40	4241.7371	3281.4591	
	5.16	SURFACE	41	4265.6004	3285.4777	
	4.08	EDGE	42	4278.1018	3285.6027	
	1.61	BOTTOM	43	4282.4645	3283.8636	
	3.55	EDGE	44	4298.4098	3287.3651	
	4.73	SURFACE	45	4304.5345	3287.1478	
	5.07	BOTTOM	46	4370.0006	3294.2450	
	5.17	SURFACE	47	4275.3659	3096.4767	
	4.69	SURFACE	48	4167.7641	2938.1006	
	4.30	EDGE	49	4157.5423	2955.2828	
	2.36	BOTTOM	50	4157.3991	2957.0793	
	4.89	EDGE	51	3027.4244	2706.6112	
	3.84	BOTTOM	52	3031.4069	2705.3799	
	3.31	BOTTOM	53	3204.2301	2690.0069	
	4.42	SURFACE	54	3206.9790	2643.1966	
	13.02	℄ ROAD @ BRIDGE	101	4765.0881	5046.2549	
1.47' ABOVE	8.91	HASH MARK @ "	102	4768.5[illegible]	5043.3[illegible]	
	-0.44	INVERT @ "A"	103	4314.1799	4283.9298	
STAFF "B" READING 3.16' →	2.98	ELEV WATER "B"	104	4854.4100	4292.4597	
	-0.57	INVERT @ "B"	105	4855.9360	4289.5292	
	-0.13	CREEK BOTTOM "B"	106	4857.0467	4288.4300	
	4.92	EDGE "#32"	107	4939.8484	4149.4911	
	-0.[illegible]4	CREEK BOTTOM "A"	108	4818.1903	4284.7[illegible]	

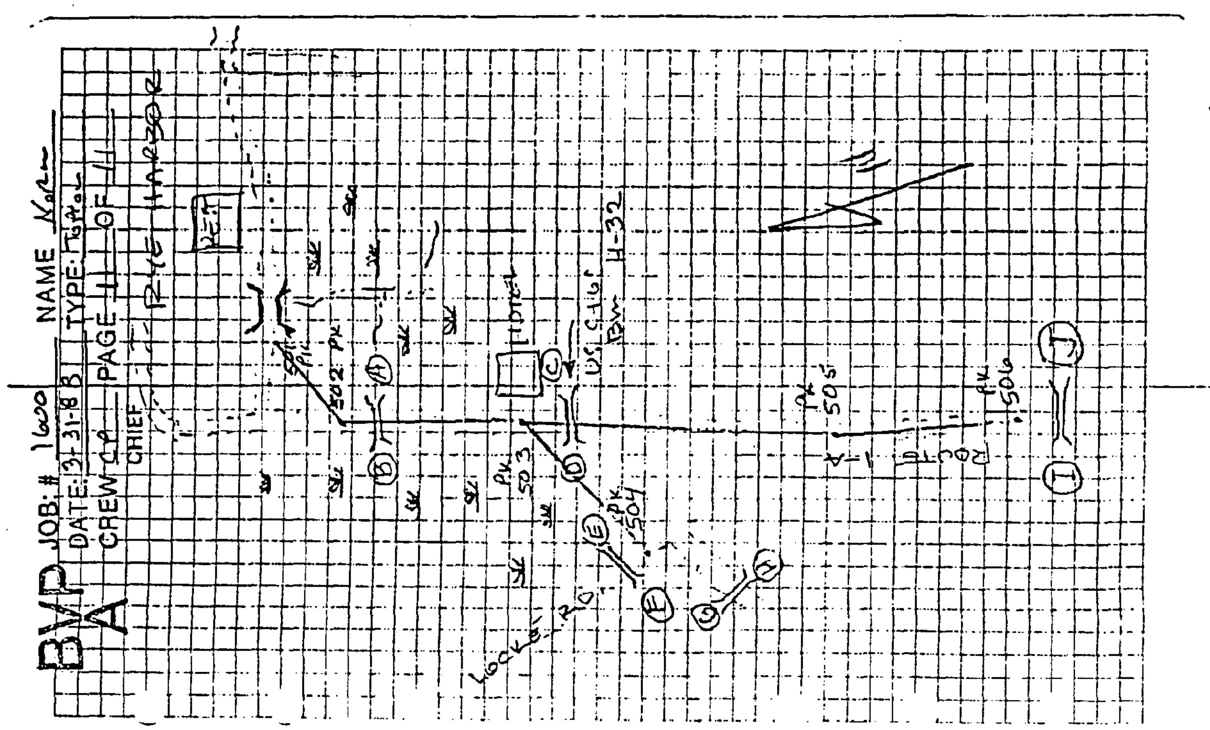
5/3/88:
Per conversation w/ C.P.
16.37 at steel casing
8.91 at hash mark

	-0.12 CREEK BOTTOM "B"	106	4857.0467	4238.6330	
	4.82 EDGE "#32"	107	4939.8484	4149.8911	
	-0.94 CREEK BOTTOM "A"	108	4813.1908	4284.7483	
℄ PAVEMENT @	8.69 ℄ CULVERT "A"	109	4836.4280	4265.7418	
	10.11 HYDRANT BOLT	110	4345.4919	3698.0622	TBM
	1.61 INVERT "C"	111	4236.6478	3675.8762	
STAFF "C" READING 0.5'	[illegible] WATER LEVEL "C"	112	4237.[illegible]	3677.[illegible]	
ELEV = 8.655	[illegible] USGS BM LOCATION	113	4238.6940	3676.0382	
	1.37 CULV "D" INVERT	114	4277.1246	3621.1057	
STATION "D" WATER LEVEL	2.79 CULV "D" WATER SURFACE	115	4275.5516	3612.7319	
℄ PVMT e ℄ CULV "D"	10.37 ℄+℄	116	4262.0554	3450.1592	
STAFF "E" = 0.1' WATER LEVEL	2.78 WATER LEVEL "E"	117	4298.8493	3211.2940	
	2.39 CULV INVERT "E"	118	4294.0055	3199.7056	
STAFF "F" = 0.2' WATER LEVEL	2.97 CULV INVERT "F"	119	4294.8622	3167.5717	
	3.63 WATER LEVEL "F"	120	4280.3454	3085.2218	
	~~[illegible]~~ STATION 503	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	
	2.98 CULV INVERT "G"	122	4215.[illegible]	[illegible]	
	2.97 CULV INVERT "H"	123	4184.9972	2966.5078	
STAFF "H" = 0.3'	3.68 WATER LEVEL "H"	124	4185.4045	2964.0980	
℄ ROAD PVMT @ CULV.	6.95 "G" → "H"	125	4198.9179	2962.3258	
" " " " "	7.69 "E" → "F"	126	4291.9929	3185.5613	
	2.37 CULV INVERT "I"	127	3106.8920	2654.4072	
STAFF "I" = 4.1'	3.95 WATER LEVEL "I"	128	3107.1650	2648.7125	
	4.22 CULV INVERT "J"	129	3054.3162	2713.7661	
STAFF "J" = 4.1'	4.65 WATER LEVEL "J"	130	3050.7654	2713.2271	ASSUMED
	11.10 STATIONS	501	5000.0000	5000.0000	COORD
	7.42	502	4948.2123	4408.0640	
	9.06	503	4336.1620	3758.4456	
	7.47	504	4245.5267	3173.5395	
	15.03	505	3746.7746	3108.6949	
25' from culvert edge of pavement	9.15	506	3082.0307	2660.1786	

TWO SHOTS BEYOND RESTAURANT TOWARD EAST:

℄ + ℄ ROAD = 8.17'

#55 SURFACE = 5.67



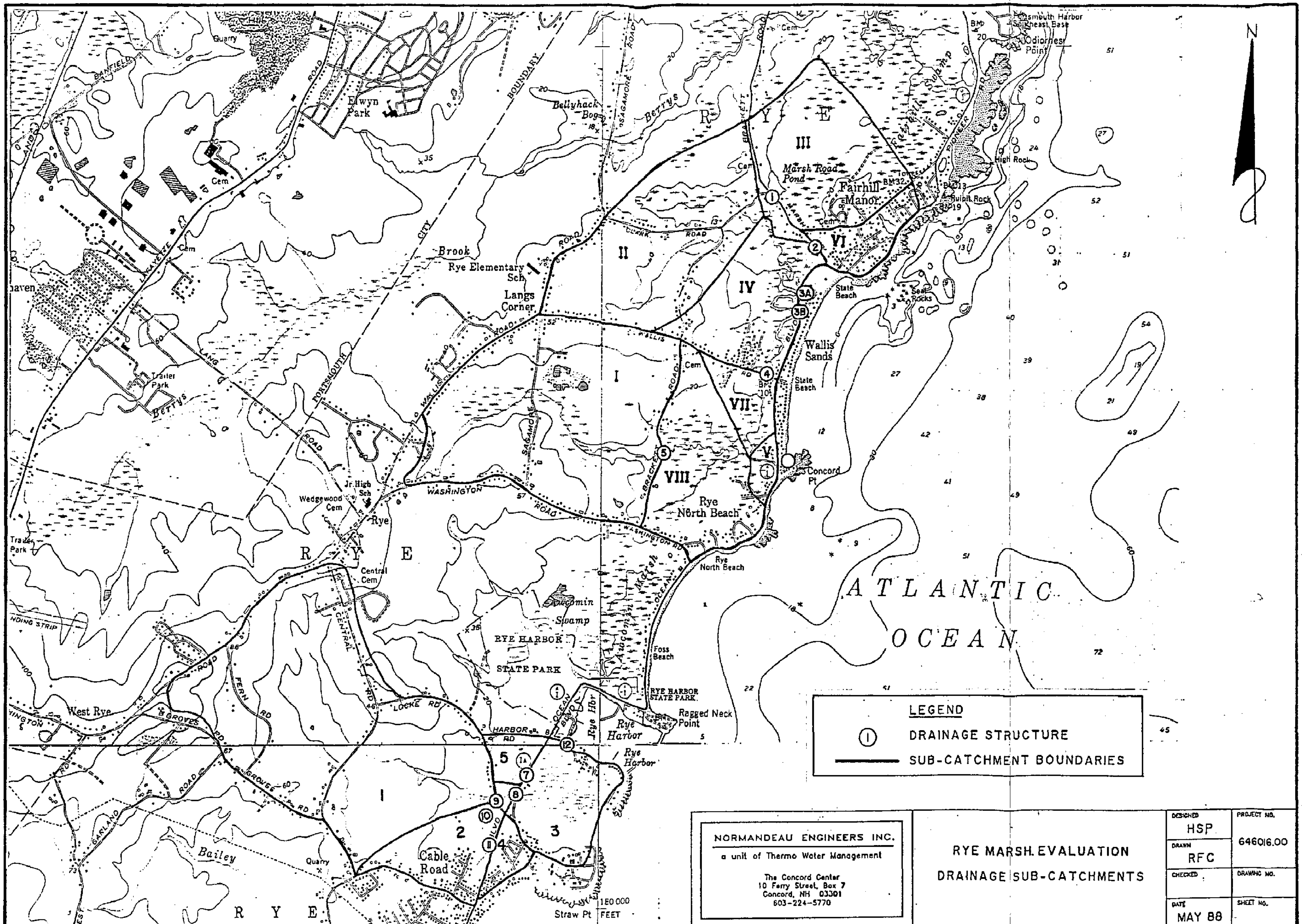
APPENDIX 2

STORMWATER RUNOFF AND TIDAL FLOOD SUMMARY DATA FOR 10-YEAR, 50-YEAR, AND 100-YEAR FLOODS

1. HEC-1 Stormwater Runoff Summary
2. Watershed Map for HEC-1
3. Army Corps of Engineers Tidal Flood Base Map
4. Army Corps of Engineers Tidal Flood Profile

RYE, NEW HAMPSHIRE
WATERSHED SUMMARY

WATERSHED	10 YEAR PEAK FLOW CFS	10 YEAR TOTAL VOL. CF	50 YEAR PEAK FLOW CFS	50 YEAR TOTAL VOL. CF	100 YEAR PEAK FLOW CFS	100 YEAR TOTAL VOL. CF
PHILBRICK						
1	44	2,600,000	78	4,900,000	92	6,200,000
2	12	1,000,000	19	1,600,000	21	1,800,000
3	72	4,700,000	121	8,300,000	140	10,400,000
4	3	300,000	4	300,000	5	500,000
5	3	300,000	4	300,000	4	300,000
SITE 7	3	300,000	4	300,000	4	300,000
SITE 10	12	1,000,000	19	1,600,000	21	1,800,000
SITES 9 & 8	56	3,600,000	97	6,500,000	113	8,000,000
SITE 11	3	300,000	4	300,000	4	300,000
SITE 12	72	4,700,000	121	8,300,000	140	10,400,000
WALLIS SANDS						
I	32	2,000,000	58	3,600,000	69	4,700,000
II	22	1,300,000	40	2,600,000	48	3,100,000
III	24	1,600,000	37	2,800,000	42	3,400,000
IV	67	4,700,000	110	8,000,000	128	10,100,000
V	126	8,800,000	212	15,300,000	248	18,900,000
VI	8	800,000	12	1,300,000	13	1,300,000
VII	73	5,400,000	121	9,000,000	140	11,100,000
VIII	51	3,100,000	88	6,000,000	104	7,500,000
SITE 1	24	1,600,000	37	2,800,000	42	3,400,000
SITE 2	8	800,000	12	1,300,000	13	1,300,000
SITE 4	67	4,700,000	110	8,000,000	128	10,100,000
SITE 5	32	2,000,000	58	3,600,000	69	4,700,000
CONCORD PT.	126	8,800,000	212	15,300,000	248	18,900,000



LEGEND

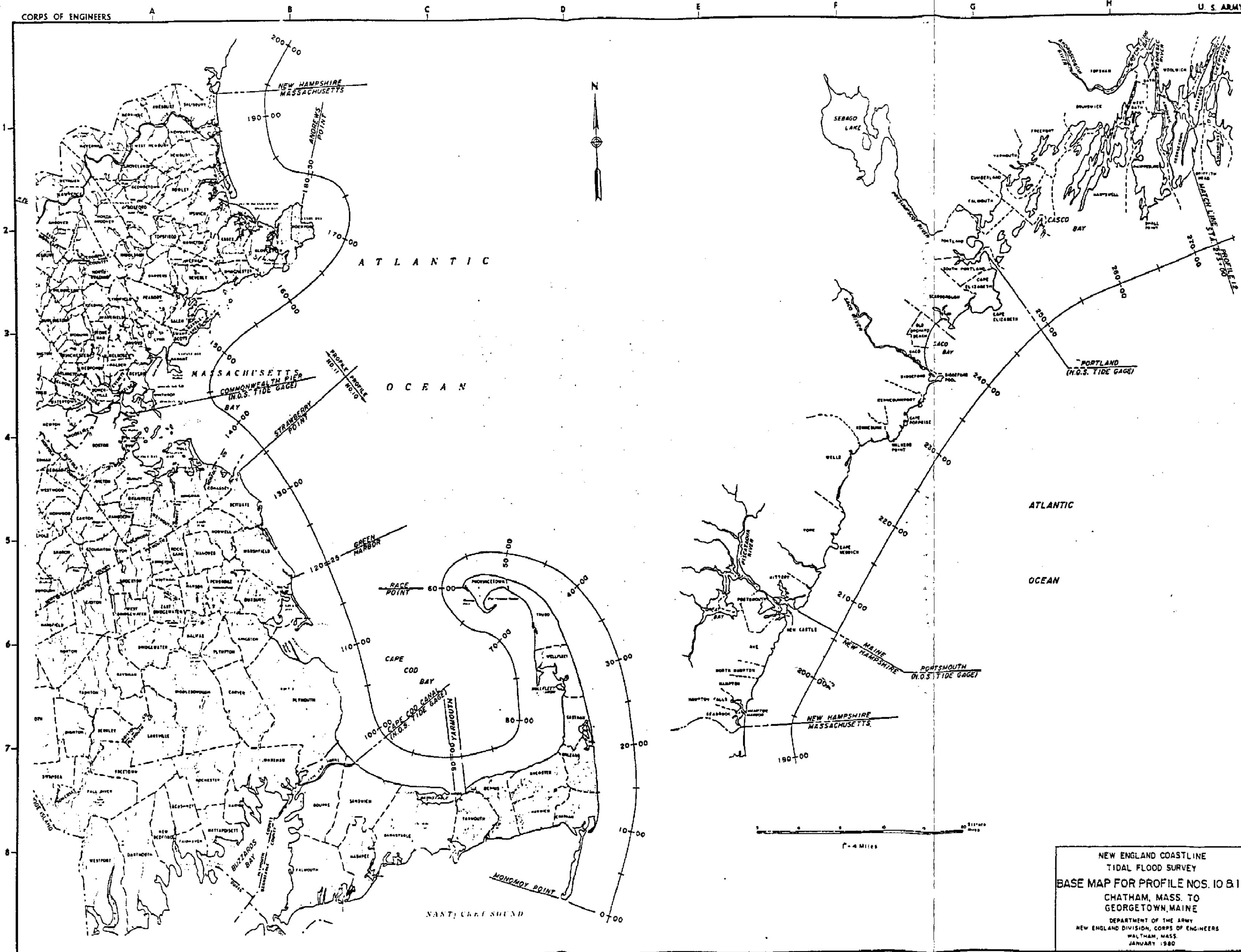
(1) DRAINAGE STRUCTURE

SUB-CATCHMENT BOUNDARIES

NORMANDEAU ENGINEERS INC.
a unit of Thermo Water Management
The Concord Center
10 Ferry Street, Box 7
Concord, NH 03301
603-224-5770

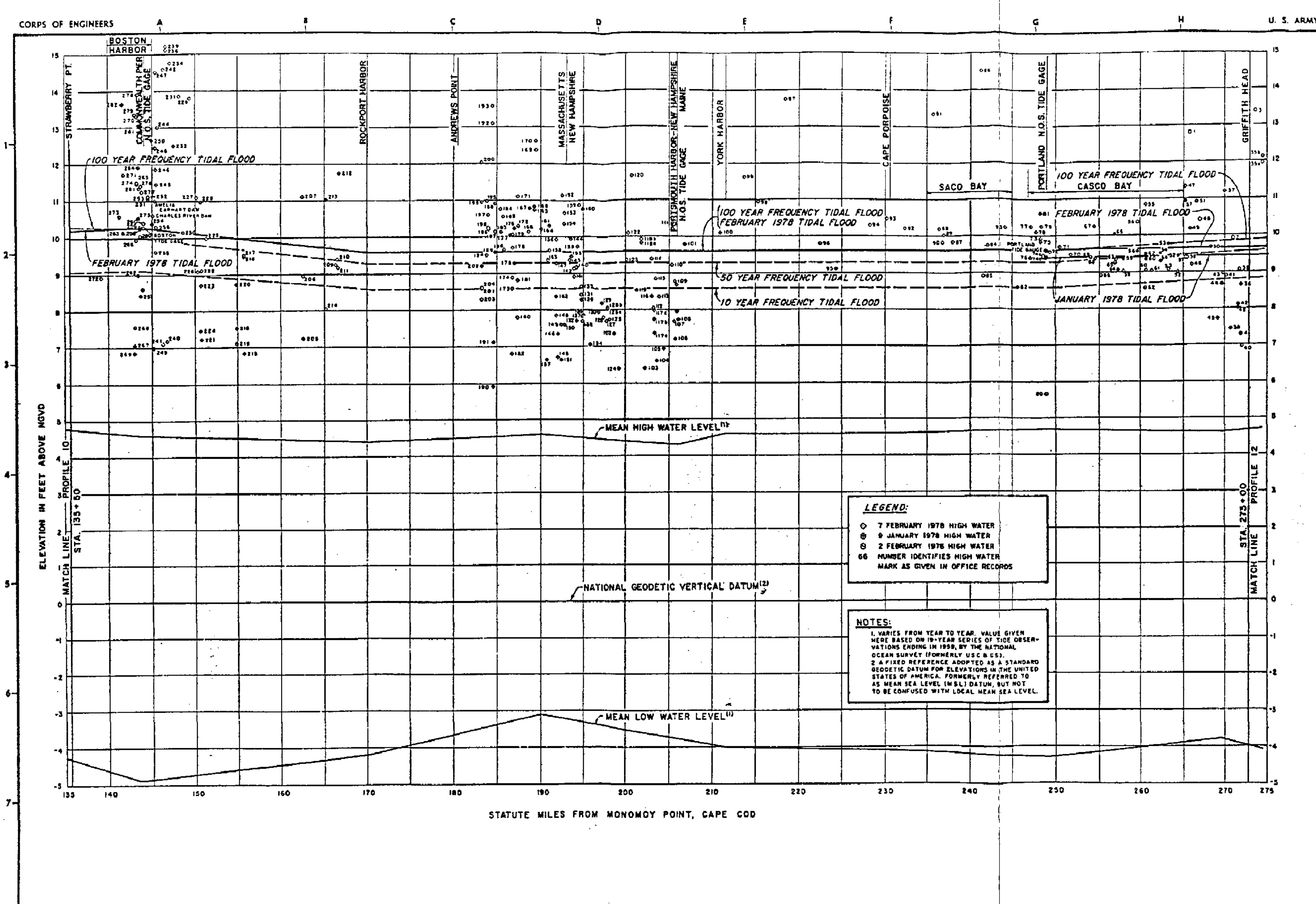
RYE MARSH EVALUATION
DRAINAGE SUB-CATCHMENTS

DESIGNED HSP	PROJECT NO. 646016.00
DRAWN RFC	
CHECKED	DRAWING NO.
DATE MAY 88	SHEET NO.



NEW ENGLAND COASTLINE
TIDAL FLOOD SURVEY
BASE MAP FOR PROFILE NOS. 10 & 11
CHATHAM, MASS. TO
GEORGETOWN, MAINE
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.
JANUARY 1980

PLATE C-24



NEW ENGLAND COASTLINE
TIDAL FLOOD SURVEY
TIDAL FLOOD PROFILE NO. 11
COHASSET, MASS. TO
GEORGETOWN, MAINE
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS
JANUARY 1980

PLATE C-26

APPENDIX 3

DATA SUMMARIES OF HYDROLOGIC SURVEY
16 MARCH 1988

1. Concord Point Bridge - Flow
2. Concord Point Bridge - Water Quality
3. Wallis Sands Stations - Flow
4. Wallis Sands Stations - Water Quality
5. Rye Harbor Bridge - Flow
6. Rye Harbor Bridge - Water Quality
7. Philbrick Brook Stations - Flow
8. Philbrick Brook Stations - Water Quality

CONFLOW.WK1 CONCORD POINT BRIDGE
TOWN OF RYE SALT MARSHES NAI PROJECT #4119
FLOW SURVEY 3-16-88

DRAFT FOR REVIEW ONLY - DATA SUBJECT TO REVISION

STATION	TIME	DIRECTION	VELOCITY	LEVELIN	INVERTIN	H2ODEPTH
1	10:10	-1	0	5.97	2.76	3.21
1	11:25	-1	-0.4	4.42	2.76	1.66
1	12:50	-1	-0.4	3.96	2.76	1.2
1	14:00	-1	-0.2	3.32	2.76	0.56
1	15:30	-1	0	3.06	2.76	0.3
1	17:45	-1	0	2.86	2.76	0.1
1	18:45	-1	0	2.86	2.76	0.1
1	19:50	1	0	3.12	2.76	0.36
1	21:35	1	0.5	5.22	2.76	2.46
1	22:30	-1	0	5.2	2.76	2.44
10	10:30	-1	-0.93	5.42	0.96	4.46
10	11:43	-1	-1.5	4.33	0.96	3.37
10	12:59	-1	-1.5	3.84	0.96	2.88
10	14:22	-1	-0.9	3.32	0.96	2.36
10	15:43	-1	-0.52	2.98	0.96	2.02
10	17:53	-1	-0.45	2.86	0.96	1.9
10	18:45	-1	0	2.86	0.96	1.9
10	20:07	1	0.6	3.54	0.96	2.58
10	21:52	1	0.3	5.35	0.96	4.39
10	22:30	-1	0	5.2	0.96	4.24
11	10:35	-1	-1.3	5.37	1.28	4.09
11	11:45	-1	-2.1	4.32	1.28	3.04
11	13:00	-1	-1.5	3.83	1.28	2.55
11	14:24	-1	-0.7	3.32	1.28	2.04
11	15:44	-1	-0.48	2.97	1.28	1.69
11	17:54	-1	-0.2	2.86	1.28	1.58
11	18:45	-1	0	2.86	1.28	1.58
11	20:09	1	0.6	3.6	1.28	2.32
11	21:54	1	0.2	5.36	1.28	4.08
11	22:30	-1	0	5.2	1.28	3.92
12	10:40	-1	-1.6	5.32	2.79	2.53
12	11:45	-1	-1.5	4.32	2.79	1.53
12	13:00	-1	-1.4	3.82	2.79	1.03
12	14:25	-1	-0.2	3.32	2.79	0.53
12	15:45	-1	-0.18	2.96	2.79	0.17
12	17:55	-1	-0.06	2.86	2.79	0.07
12	18:45	-1	0	2.86	2.79	0.07
12	20:10	1	0.3	3.68	2.79	0.89
12	21:55	1	0.1	5.36	2.79	2.57
12	22:30	-1	0	5.2	2.79	2.41
2	10:10	-1	0	5.87	2.91	2.96
2	11:27	-1	-0.9	4.41	2.91	1.5
2	12:51	-1	-0.4	3.94	2.91	1.03
2	14:00	-1	-0.2	3.32	2.91	0.41
2	15:30	-1	0	3.06	2.91	0.15
2	17:45	-1	0	2.86	2.91	-0.05
2	18:45	-1	0	2.86	2.91	-0.05
2	19:50	1	0	3.12	2.91	0.21
2	21:36	1	0.5	5.23	2.91	2.32
2	22:30	-1	0	5.2	2.91	2.29
3	10:15	-1	-0.64	5.77	2.76	3.01

3	11:29	-1	-1.2	4.4	2.76	1.64
3	12:52	-1	-0.9	3.92	2.76	1.16
3	14:02	-1	-0.2	3.32	2.76	0.56
3	15:30	-1	-0.2	3.05	2.76	0.29
3	17:45	-1	0	2.86	2.76	0.1
3	18:45	-1	0	2.86	2.76	0.1
3	19:50	1	0.29	3.06	2.76	0.3
3	21:38	1	0.4	5.25	2.76	2.49
3	22:30	-1	0	5.2	2.76	2.44
4	10:15	-1	-0.47	5.72	2.46	3.26
4	11:31	-1	-1.2	4.39	2.46	1.93
4	12:53	-1	-1.1	3.9	2.46	1.44
4	14:05	-1	-0.6	3.32	2.46	0.86
4	15:32	-1	-0.3	3.04	2.46	0.58
4	17:45	-1	0	2.86	2.46	0.4
4	18:45	-1	0	2.86	2.46	0.4
4	19:53	1	0.7	3.12	2.46	0.66
4	21:40	1	0.6	5.26	2.46	2.8
4	22:30	-1	0	5.2	2.46	2.74
5	10:20	-1	-0.68	5.67	1.91	3.76
5	11:33	-1	-1.3	4.38	1.91	2.47
5	12:54	-1	-1.3	3.89	1.91	1.98
5	14:07	-1	-0.7	3.32	1.91	1.41
5	15:34	-1	-0.35	3.03	1.91	1.12
5	17:45	-1	-0.33	2.86	1.91	0.95
5	18:45	-1	0	2.86	1.91	0.95
5	19:56	1	0.75	3.19	1.91	1.28
5	21:42	1	0.5	5.28	1.91	3.37
5	22:30	-1	0	5.2	1.91	3.29
6	10:20	-1	-0.91	5.62	1.36	4.26
6	11:35	-1	-2.1	4.37	1.36	3.01
6	12:55	-1	-1.4	3.88	1.36	2.52
6	14:10	-1	-0.8	3.32	1.36	1.96
6	15:36	-1	-0.46	3.02	1.36	1.66
6	17:46	-1	-0.4	2.86	1.36	1.5
6	18:45	-1	0	2.86	1.36	1.5
6	19:58	1	0.7	3.26	1.36	1.9
6	21:44	1	0.5	5.29	1.36	3.93
6	22:30	-1	0	5.2	1.36	3.84
7	10:25	-1	-1.1	5.57	1.01	4.56
7	11:37	-1	-1.8	4.36	1.01	3.35
7	12:56	-1	-1.5	3.87	1.01	2.86
7	14:14	-1	-0.8	3.32	1.01	2.31
7	15:38	-1	-0.38	3.01	1.01	2
7	17:48	-1	-0.33	2.86	1.01	1.85
7	18:45	-1	0	2.86	1.01	1.85
7	20:00	1	1.15	3.33	1.01	2.32
7	21:46	1	0.8	5.31	1.01	4.3
7	22:30	-1	0	5.2	1.01	4.19
8	10:25	-1	-1.41	5.52	1.11	4.41
8	11:39	-1	-2.1	4.35	1.11	3.24
8	12:57	-1	-1.5	3.86	1.11	2.75
8	14:18	-1	-0.9	3.32	1.11	2.21
8	15:40	-1	-0.52	3	1.11	1.89
8	17:49	-1	-0.33	2.86	1.11	1.75
8	18:45	-1	0	2.86	1.11	1.75
8	20:03	1	1	3.4	1.11	2.29
8	21:48	1	0.1	5.32	1.11	4.21
8	22:30	-1	0	5.2	1.11	4.09
9	10:30	-1	-1.08	5.47	1.11	4.36

9	11:41	-1	-1.6	4.34	1.11	3.23
9	12:58	-1	-1.5	3.85	1.11	2.74
9	14:20	-1	-0.8	3.32	1.11	2.21
9	15:42	-1	-0.6	2.99	1.11	1.88
9	17:51	-1	-0.3	2.86	1.11	1.75
9	18:45	-1	0	2.86	1.11	1.75
9	20:05	1	0.7	3.47	1.11	2.36
9	21:50	1	0.5	5.34	1.11	4.23
9	22:30	-1	0	5.2	1.11	4.09

CONQUAL.WK1 CONCORD POINT BRIDGE
TOWN OF RYE SALT MARSHES
WATER QUALITY SURVEY 3-16-88

DRAFT FOR REVIEW ONLY - DATA SUBJECT TO REVISION

STATION	TIME	DIRECTION	TEMP	COND	SAL
1	10:10	-1	4	28000	30
1	11:25	-1	7	30000	30
1	12:50	-1	6	27000	27
1	14:00	-1	7	23000	22
1	15:30	-1	0	0	0
1	17:45	-1	0	0	0
1	18:45	-1	0	0	0
1	19:50	1	0	0	0
1	21:35	1	3	27000	30
1	22:30	-1	0	0	0
10	10:30	-1	4	28500	30.5
10	11:43	-1	5	30000	31
10	12:59	-1	6	27000	27
10	14:22	-1	6	22000	22
10	15:43	-1	7	20100	19.5
10	17:53	-1	6	19000	18
10	18:45	-1	0	0	0
10	20:07	1	4	27000	29
10	21:52	1	4	27000	29
10	22:30	-1	0	0	0
11	10:35	-1	4	29000	31
11	11:45	-1	5	30000	31
11	13:00	-1	6	27000	27
11	14:24	-1	6	22000	22
11	15:44	-1	7	20100	19.5
11	17:54	-1	6	19000	18
11	18:45	-1	0	0	0
11	20:09	1	4	27000	29
11	21:54	1	4	27000	29
11	22:30	-1	0	0	0
12	10:40	-1	4	28500	31
12	11:45	-1	6	30000	30
12	13:00	-1	6	27000	27
12	14:25	-1	6	22000	22
12	15:45	-1	7	20100	19.5
12	17:55	-1	6	19000	18
12	18:45	-1	0	0	0
12	20:10	1	4	27000	29
12	21:55	1	4	27000	29
12	22:30	-1	0	0	0
2	10:10	-1	4	28000	30
2	11:27	-1	6	30000	30
2	12:51	-1	6	27000	27
2	14:00	-1	7	23000	22
2	15:30	-1	0	0	0
2	17:45	-1	0	0	0
2	18:45	-1	0	0	0
2	19:50	1	0	0	0
2	21:36	1	3	28000	30
2	22:30	-1	0	0	0
3	10:15	-1	4	28000	30

3	11:29	-1	5	30000	31
3	12:52	-1	6	27000	27
3	14:02	-1	7	23000	22
3	15:30	-1	6	21000	20.5
3	17:45	-1	0	0	0
3	18:45	-1	0	0	0
3	19:50	1	0	0	0
3	21:38	1	4	27000	29
3	22:30	-1	0	0	0
4	10:15	-1	4	28000	30
4	11:31	-1	5	30000	31
4	12:53	-1	6	27000	27
4	14:05	-1	7	23000	22
4	15:32	-1	6	21000	20.5
4	17:45	-1	0	0	0
4	18:45	-1	0	0	0
4	19:53	1	5	17000	17
4	21:40	1	4	28000	29
4	22:30	-1	0	0	0
5	10:20	-1	4	28000	30
5	11:33	-1	5	30000	31
5	12:54	-1	6	27000	27
5	14:07	-1	7	23000	22
5	15:34	-1	7	20500	19.8
5	17:45	-1	6	19000	18
5	18:45	-1	0	0	0
5	19:56	1	4	33000	25
5	21:42	1	4	27000	29
5	22:30	-1	0	0	0
6	10:20	-1	4	28000	30
6	11:35	-1	5	30000	31
6	12:55	-1	6	27000	27
6	14:10	-1	7	23000	22
6	15:36	-1	7	20500	19.8
6	17:46	-1	6	19000	18
6	18:45	-1	0	0	0
6	19:58	1	4	25000	26
6	21:44	1	4	28000	29
6	22:30	-1	0	0	0
7	10:25	-1	4	28000	30
7	11:37	-1	5	30000	31
7	12:56	-1	6	27000	27
7	14:14	-1	6	22000	22
7	15:38	-1	7	20500	19.8
7	17:48	-1	6	19000	18
7	18:45	-1	0	0	0
7	20:00	1	4	26000	27
7	21:46	1	4	28000	29
7	22:30	-1	0	0	0
8	10:25	-1	4	28500	30.5
8	11:39	-1	5	30000	31
8	12:57	-1	6	27000	27
8	14:18	-1	6	22000	22
8	15:40	-1	7	20000	19.8
8	17:49	-1	6	19000	18
8	18:45	-1	0	0	0
8	20:03	1	4	26000	28
8	21:48	1	4	27000	29
8	22:30	-1	0	0	0
9	10:30	-1	4	28500	30.5

9	11:41	-1	5	29000	30
9	12:58	-1	6	26000	27
9	14:20	-1	6	22000	22
9	15:42	-1	7	20000	19.5
9	17:51	-1	6	19000	18
9	18:45	-1	0	0	0
9	20:05	1	4	27000	28
9	21:50	1	4	27000	29
9	22:30	-1	0	0	0

waflow.wk1
Town of Rye Salt Marshes NAI Project #4119
Wallis Sands Flow Survey 3-16-88

DRAFT FOR REVIEW ONLY - DATA SUBJECT TO REVISION

STATION	TIME	DIRECTION	VELOCITY	LEVELIN	LEVELOUT	INVERTIN
1	12:25	-1	-1.1	5.01	4.8	4.11
1	13:16	-1	-1.2	5.01	4.78	4.11
1	15:10	-1	-0.8	5.01	4.75	4.11
1	16:40	-1	-1.25	5.01	4.73	4.11
1	18:10	-1	0	5.01	4.74	4.11
1	21:30	-1	-1	5.02	4.71	4.11
1	22:45	-1	-1	5.02	4.74	4.11
1	23:40	-1	-1	5.01	4.75	4.11
2	12:17	-1	-0.5	4.92	4.9	2.72
2	13:23	-1	-0.8	4.95	4.91	2.72
2	15:05	-1	-0.08	4.97	4.9	2.72
2	16:45	-1	-0.08	4.95	4.9	2.72
2	18:15	-1	0	4.95	4.92	2.72
2	21:25	-1	-0.01	4.95	4.9	2.72
2	22:50	-1	-0.07	4.95	4.92	2.72
2	23:35	-1	0	4.95	4.9	2.72
3.1	12:12	1	0.57	4.55	4.74	3.52
3.1	15:00	-1	-0.27	4.57	4.44	3.52
3.1	16:55	-1	-0.26	4.54	4.44	3.52
3.1	18:20	-1	0	4.51	4.44	3.52
3.1	21:20	1	0.28	4.49	4.44	3.52
3.1	22:55	1	0.6	4.55	4.54	3.52
3.1	23:32	1	0.01	4.56	4.49	3.52
3.2	12:05	1	0.08	4.44	4.6	3.92
3.2	13:35	-1	-0.05	4.44	4.52	3.92
3.2	14:55	-1	-0.14	4.56	4.52	3.92
3.2	17:00	-1	-0.17	4.52	4.48	3.92
3.2	18:25	-1	0	4.52	4.43	3.92
3.2	21:10	-1	-0.01	4.49	4.42	3.92
3.2	23:00	1	0.07	4.55	4.55	3.92
3.2	23:30	-1	0	4.56	4.55	3.92
4	11:10	1	0	4.85	4.85	2.61
4	12:30	-1	-0.6	4.57	4.57	2.61
4	13:45	-1	-0.9	4.37	4.37	2.61
4	14:45	-1	-0.8	4.33	4.33	2.61
4	15:20	-1	-0.35	4.33	4.33	2.61
4	17:05	-1	-0.5	4.31	4.31	2.61
4	18:00	-1	-0.7	4.29	4.29	2.61
4	18:33	-1	-0.4	4.28	4.28	2.61
4	21:05	1	0.8	4.67	4.67	2.61
4	22:20	1	1.2	4.73	4.73	2.61
4	23:10	1	0.01	4.67	4.67	2.61
	23:30					
4.1	11:10	1	0	4.83	4.83	0
4.1	12:30	-1	0	4.53	4.53	0
4.1	13:45	-1	0	4.53	4.53	0
4.1	14:45	-1	0	4.5	4.5	0
4.1	15:20	-1	0	4.48	4.48	0
4.1	17:05	-1	0	4.43	4.43	0
4.1	18:00	-1	0	4.43	4.43	0
4.1	18:33	-1	0	4.43	4.43	0

4.1	21:05	1	0	4.53	4.53	0
4.1	22:20	1	0	4.63	4.63	0
4.1	23:10	1	0	4.55	4.55	0
4.2	11:10	1	0	4.75	4.75	0
4.2	12:00	1	0	4.45	4.45	0
4.2	12:30	-1	0	4.16	4.16	0
4.2	13:45	-1	0	3.95	3.95	0
4.2	14:45	-1	0	3.87	3.87	0
4.2	15:20	-1	0	3.87	3.87	0
4.2	17:05	-1	0	3.85	3.85	0
4.2	18:00	-1	0	3.85	3.85	0
4.2	18:33	-1	0	3.85	3.85	0
4.2	21:05	1	0	4.36	4.36	0
4.2	22:20	1	0	4.75	4.75	0
4.2	23:10	1	0	4.25	4.25	0
con1	10:10	-1	0	5.97	5.97	2.76
con1	11:25	-1	-0.4	4.42	4.42	2.76
con1	12:50	-1	-0.4	3.96	3.96	2.76
con1	14:00	-1	-0.2	3.32	3.32	2.76
con1	15:30	-1	0	3.06	3.06	2.76
con1	17:45	-1	0	2.86	2.86	2.76
con1	18:45	-1	0	2.86	2.86	2.76
con1	19:50	1	0	3.12	3.12	2.76
con1	21:35	1	0.5	5.22	5.22	2.76
con1	22:30	-1	0	5.2	5.2	2.76
5	10:52	-1	-0.4	5.18	5.18	3.5
5	13:10	-1	-1.2	4.1	4.1	3.5
5	14:35	-1	-0.5	3.8	3.72	3.5
5	15:55	-1	-1	3.8	3.7	3.5
5	17:30	-1	-0.8	3.8	3.7	3.5
5	18:40	-1	0	3.8	3.7	3.5
5	21:00	-1	-0.2	4.15	4.18	3.5
5	22:10	1	0.1	4.7	4.71	3.5
5	22:40	-1	-1	4.7	4.75	3.5
con10	10:30	-1	-0.93	5.42	5.42	0.96
con10	11:43	-1	-1.5	4.33	4.33	0.96
con10	12:59	-1	-1.5	3.84	3.84	0.96
con10	14:22	-1	-0.9	3.32	3.32	0.96
con10	15:43	-1	-0.52	2.98	2.98	0.96
con10	17:53	-1	-0.45	2.86	2.86	0.96
con10	18:45	-1	0	2.86	2.86	0.96
con10	20:07	1	0.6	3.54	3.54	0.96
con10	21:52	1	0.3	5.35	5.35	0.96
con10	22:30	-1	0	5.2	5.2	0.96
11	16:05	1	1.1			
12	16:15	1	0.5			
13	16:30	1	1.2			

WAQUAL.WK1 WALLIS SANDS CULVERTS
TOWN OF RYE SALT MARSHES
WATER QUALITY SURVEY 3-16-88

DRAFT FOR REVIEW ONLY - DATA SUBJECT TO REVISION

STATION	TIME	DIRECTION	TEMP	COND	SAL
1	12:25	-1	8	1	0
1	13:16	-1	9	900	0
1	15:10	-1	9	650	0
1	16:40	-1	9	700	0
1	18:10	-1			
1	21:30	-1			
1	22:45	-1			
1	23:40	-1			
2	12:17	-1	7	0	0
2	13:23	-1	9	400	0
2	15:05	-1	9	300	0
2	16:45	-1	8	200	0
2	18:15	-1			
2	21:25	-1			
2	22:50	-1	3	400	0
2	23:35	-1			
3.1	12:12	1	6	20000	20
3.1	13:30	-1	7	12000	11
3.1	15:00	-1	8	14000	14
3.1	16:55	-1	7	5000	4.5
3.1	18:20	-1			
3.1	21:20	1	5	14000	17
3.1	22:55	1	4	15000	16
3.1	23:32	1			
3.2	12:05	1	5	15000	15
3.2	13:35	-1	9	10000	9
3.2	14:55	-1	6	8000	8
3.2	17:00	-1	6	4100	3.5
3.2	18:25	-1			
3.2	21:10	-1			
3.2	23:00	1	1	7000	7
3.2	23:30	-1			
4	11:10	1			
4	12:00	1	6	28000	28
4	12:30	-1	6	27000	27
4	13:45	-1	7	24000	23
4	14:45	-1	7	23000	22
4	15:20	-1	6.5	23000	22.3
4	17:05	-1	7	18000	17
4	18:00	-1	6	17000	16
4	18:33	-1	6	16000	15
4	21:05	1	5	13000	13
4	22:20	1	4	25000	27
4	23:10	1	2	25000	28
4.1	11:10	1			
4.1	12:00	1			
4.1	12:30	-1			
4.1	13:45	-1			
4.1	14:45	-1			
4.1	15:20	-1			
4.1	17:05	-1			

4.1	18:00	-1			
4.1	18:33	-1			
4.1	21:05	1			
4.1	22:20	1			
4.1	23:10	1			
4.2	11:10	1			
4.2	12:00	1			
4.2	12:30	-1			
4.2	13:45	-1			
4.2	14:45	-1			
4.2	15:20	-1			
4.2	17:05	-1			
4.2	18:00	-1			
4.2	18:33	-1			
4.2	21:05	1			
4.2	22:20	1			
4.2	23:10	1			
5	10:52	-1	3	24000	26
5	13:10	-1	3	600	0
5	14:35	-1	4	200	0
5	15:55	-1	3	150	0
5	17:30	-1	4	100	0
5	18:40	-1			
5	21:00	-1	1	110	0
5	22:10	1	1	100	0
5	22:40	-1			
11	16:05	1			
12	16:15	1			
13	16:30	1			
5	15.55	-1	-1	4.1	4
5	17.3	-1	-0.8	4.1	4
5	18.4	-1	0	4.1	4
5	21	-1	-0.2	3.18	5.75
5	22.1	1	0.1	5	5.01
5	22.4	-1	-1	5	5.05
11	16.05	1	1.1	0	0
12	16.15	1	0.5	0	0
13	16.3	1	1.2	0	0
CON10	10:30	-1	4	28500	30.5
CON10	11:43	-1	5	30000	31
CON10	12:59	-1	6	27000	27
CON10	14:22	-1	6	22000	22
CON10	15:43	-1	7	20100	19.5
CON10	17:53	-1	6	19000	18
CON10	18:45	-1			
CON10	20:07	1	4	27000	29
CON10	21:52	1	4	27000	29
CON10	22:30	-1			

RYEFLOW.WK1 RYE HARBOR BRIDGE
TOWN OF RYE SALT MARSHES NAI PROJECT #4119
FLOW SURVEY 3-16-88

DRAFT FOR REVIEW ONLY - DATA SUBJECT TO REVISION

STATION	TIME	DIRECTION	VELOCITY	LEVELIN	INVERTIN	H2ODEPTH
101	09:15	1	1.38	8.37	-0.19	8.6
101	10:45	-1	-2.2	7.02	-0.19	7.2
101	12:10	-1	-2.6	3.02	-0.19	3.2
101	13:03	-1	-1.3	2.02	-0.19	2.2
101	13:51	-1	-1.1	1.52	-0.19	1.7
101	14:32	-1	-0.6	1.17	-0.19	1.4
101	15:35	-1	-0.6	1.02	-0.19	1.2
101	16:25	-1	-0.6	0.97	-0.19	1.2
101	17:25	-1	-0.4	0.92	-0.19	1.1
102	18:22	1	0.4	1.52	0.86	0.7
102	20:11	-1	-0.6	5.82	0.86	5
102	21:02	1	0.8	7.92	0.86	7.1
102	21:53	1	0.1	7.32	0.86	6.5
201	09:24	1	2.15	8.37	0.31	8.1
201	10:51	-1	-4.2	7.02	0.31	6.7
201	12:12	-1	-3.6	3.02	0.31	2.7
201	13:09	-1	-2.8	2.02	0.31	1.7
201	13:53	-1	0	1.52	0.31	1.2
201	14:33	-1	0	1.17	0.31	0.9
201	15:37	-1	0	1.02	0.31	0.7
201	16:27	-1	0	0.97	0.31	0.7
201	17:26	-1	0	0.92	0.31	0.6
202	18:24	1	0.9	1.52	0.11	1.4
202	20:14	1	1.9	5.82	0.11	5.7
202	21:04	1	1.9	7.92	0.11	7.8
202	21:54	1	0.2	7.32	0.11	7.2
301	09:30	1	1.9	8.37	0.41	8
301	10:55	-1	-4.9	7.02	0.41	6.6
301	12:14	-1	-3.6	3.02	0.41	2.6
301	13:11	-1	-2.7	2.02	0.41	1.6
301	13:54	-1	-2	1.52	0.41	1.1
301	14:35	-1	-1.7	1.17	0.41	0.8
301	15:38	-1	-1	1.02	0.41	0.6
301	16:27	-1	-1.1	0.97	0.41	0.6
301	17:26	-1	-0.6	0.92	0.41	0.5
302	18:25	1	1.5	1.52	0.11	1.4
302	20:16	1	2.2	5.82	0.11	5.7
302	21:06	1	1.8	7.92	0.11	7.8
302	21:55	1	0.2	7.32	0.11	7.2
401	09:36	1	0	8.37	0.21	8.2
401	10:59	-1	-4.3	7.02	0.21	6.8
401	12:16	-1	-3.2	3.02	0.21	2.8
401	13:13	-1	-2.7	2.02	0.21	1.8
401	13:55	-1	-2.7	1.52	0.21	1.3
401	14:37	-1	-2.4	1.17	0.21	1
401	15:40	-1	-1.5	1.02	0.21	0.8
401	16:28	-1	-1.3	0.97	0.21	0.8
401	17:27	-1	-0.8	0.92	0.21	0.7
402	18:27	1	0.5	1.52	0.61	0.9
402	20:18	1	1.8	5.82	0.61	5.2
402	21:08	1	1.4	7.92	0.61	7.3
402	21:57	1	0.3	7.32	0.61	6.7

501	09:41	-1	-0.85	8.37	-0.09	8.5
501	11:02	-1	-4.8	7.02	-0.09	7.1
501	12:18	-1	-4.1	3.02	-0.09	3.1
501	13:15	-1	-2.9	2.02	-0.09	2.1
501	13:57	-1	-2.3	1.52	-0.09	1.6
501	14:38	-1	-2.2	1.17	-0.09	1.3
501	15:42	-1	-1.3	1.02	-0.09	1.1
501	16:30	-1	-1.4	0.97	-0.09	1.1
501	17:28	-1	-0.8	0.92	-0.09	1
502	18:29	1	0.8	1.52	0.01	1.5
502	20:20	1	1.9	5.82	0.01	5.8
502	21:10	1	1.7	7.92	0.01	7.9
502	21:58	1	0.2	7.32	0.01	7.3
601	09:45	-1	-1.7	8.37	0.81	7.6
601	11:04	-1	-3	7.02	0.81	6.2
601	12:20	-1	-2.6	3.02	0.81	2.2
601	13:17	-1	-0.6	2.02	0.81	1.2
601	13:58	-1	-0.5	1.52	0.81	0.7
601	14:39	-1	-0.5	1.17	0.81	0.4
601	15:44	-1	-0.3	1.02	0.81	0.2
601	16:31	-1	-0.2	0.97	0.81	0.2
601	17:29	-1	0	0.92	0.81	0.1
602	18:31	1	0.6	1.52	0.61	0.9
602	20:22	1	2	5.82	0.61	5.2
602	21:12	1	1.4	7.92	0.61	7.3
602	22:00	1	0.2	7.32	0.61	6.7

RYEQUAL.WK1 RYE HARBOR BRIDGE
TOWN OF RYE SALT MARSHES NAI PROJECT #4119
WATER QUALITY SURVEY 3-16-88

DRAFT FOR REVIEW ONLY - DATA SUBJECT TO REVISION

STATION	TIME	DIRECTION	TEMP	COND	SAL
100	09:15	1	3.25	28900	30.5
100	10:45	-1	4.1	29100	30
100	12:10	-1	5.4	28600	28.8
100	13:03	-1	6	25300	24.1
100	13:51	-1	6.9	22200	20.6
100	14:32	-1	6.8	19700	18.3
100	15:35	-1	7	17400	16
100	16:25	-1	5.9	14900	14.1
100	17:25	-1	5.9	12900	11.9
100	18:22	1	5	19000	18
100	20:11	-1	3.1	28900	31
100	21:02	1	3	28900	31
100	21:53	1	3	29000	31
200	09:24	1	3	28900	30.8
200	10:51	-1	4	29100	30.4
200	12:12	-1	5.4	28600	28.5
200	13:09	-1	5.8	25200	24.3
200	13:53	-1	0	0	0
200	14:33	-1	0	0	0
200	15:37	-1	0	0	0
200	16:27	-1	0	0	0
200	17:26	-1	0	0	0
200	18:24	1	4.8	24900	24.5
200	20:14	1	3	28900	31.1
200	21:04	1	3	29000	31
200	21:54	1	3	29000	31.1
300	09:30	1	3	28900	30.7
300	10:55	-1	4	29200	30.4
300	12:14	-1	5.2	28600	28.8
300	13:11	-1	5.8	25100	24.6
300	13:54	-1	6.6	22000	20.8
300	14:35	-1	6.8	19500	18.1
300	15:38	-1	6.5	17200	15.9
300	16:27	-1	5.9	14800	13.9
300	17:26	-1	5.4	12600	11.8
300	18:25	1	4.5	26000	26.1
300	20:16	1	3	29000	31
300	21:06	1	3	28900	31
300	21:55	1	2.9	29000	31.4
400	09:36	1	3	28900	30.8
400	10:59	-1	4.1	29100	30.4
400	12:16	-1	5.1	29600	28.7
400	13:13	-1	5.9	25000	24.2
400	13:55	-1	6.7	21900	20.4
400	14:37	-1	6.8	19400	18
400	15:40	-1	6.3	17000	15.9
400	16:28	-1	6	14800	13.9
400	17:27	-1	5.3	12500	11.7
400	18:27	1	4.5	26000	26.1
400	20:18	1	3	29000	31.1
400	21:08	1	3.1	28900	30.9
400	21:57	1	2.9	29000	31.5

500	09:41	-1	3	28950	30.9
500	11:02	-1	4.2	29100	30.3
500	12:18	-1	5.1	28600	28.7
500	13:15	-1	5.9	25000	24
500	13:57	-1	6.8	21900	20.4
500	14:38	-1	6.8	19400	18
500	15:42	-1	6.2	16900	15.8
500	16:30	-1	6	14700	13.8
500	17:28	-1	5.2	12400	11.6
500	18:29	1	4.3	27100	27.8
500	20:20	1	3	29000	31.1
500	21:10	1	3.2	28700	30.7
500	21:58	1	2.9	29000	31.4
600	09:45	-1	3	29000	31
600	11:04	-1	4.2	29200	30.2
600	12:20	-1	5.2	28600	28.6
600	13:17	-1	5.9	24900	24.1
600	13:58	-1	6.8	22000	20.8
600	14:39	-1	6.7	19700	18.3
600	15:44	-1	6.3	16900	15.8
600	16:31	-1	5.8	14600	13.8
600	17:29	-1	0	0	0
600	18:31	1	4.2	27000	27.5
600	20:22	1	3	29000	31
600	21:12	1	3.1	28700	30.7
600	22:00	1	2.9	29000	31.6

PHILFLOW.WK1 PHILBRICK CULVERTS
TOWN OF RYE SALT MARSHES NAI PROJECT #4119
FLOW SURVEY 3-16-88

DRAFT FOR REVIEW ONLY - DATA SUBJECT TO REVIEW

STATION	TIME	DIRECTION	VELOCITY	LEVELIN	LEVELOUT	INVERTIN	INVERTOUT
10	10:23	1	2.3	5.43	5.45	2.97	2.98
10	11:25	-1	-2.1	5.33	5.33	2.97	2.98
10	12:43	-1	-1.7	4.98	4.79	2.97	2.98
10	13:35	-1	-1.7	4.64	4.45	2.97	2.98
10	14:18	-1	-1.3	4.36	4.22	2.97	2.98
10	14:54	-1	-1	4.14	4.03	2.97	2.98
10	16:00	-1	-0.7	3.88	3.81	2.97	2.98
10	16:47	-1	-0.4	3.75	3.73	2.97	2.98
10	17:45	-1	-0.6	3.73	3.68	2.97	2.98
10	18:53	-1	-2.7	3.68	3.63	2.97	2.98
10	20:41	1	2.6	4.13	4.18	2.97	2.98
10	21:29	1	3	4.78	4.83	2.97	2.98
10	22:22	1	0.8	5.05	5.03	2.97	2.98
11	10:32	1	0.8	5.45	5.55	4.22	4.37
11	11:32	-1	-0.4	5.43	5.45	4.22	4.37
11	12:48	-1	-0.6	5.11	5.07	4.22	4.37
11	13:41	-1	-0.3	4.85	4.75	4.22	4.37
11	14:24	-1	-0.2	4.72	4.5	4.22	4.37
11	15:00	-1	-0.1	4.7	4.25	4.22	4.37
11	16:07	-1	-0.1	4.7	4.01	4.22	4.37
11	16:53	-1	-0.01	4.65	3.95	4.22	4.37
11	17:51	-1	-0.2	4.65	3.93	4.22	4.37
11	19:10	-1	-0.01	4.56	3.92	4.22	4.37
11	20:50	-1	-0.1	4.65	4.15	4.22	4.37
11	21:35	1	0.2	4.7	4.72	4.22	4.37
11	22:30	1	0.2	5.05	5.1	4.22	4.37
7	09:57	-1	-0.5	5.66	5.65	-0.57	-0.44
7	11:11	-1	-0.3	5.28	5.27	-0.57	-0.44
7	12:27	-1	-0.8	0.88	0.9	-0.57	-0.44
7	13:21	-1	-0.4	0.28	0.29	-0.57	-0.44
7	14:05	-1	-0.5	0.18	0.25	-0.57	-0.44
7	14:43	-1	-0.5	0.18	0.25	-0.57	-0.44
7	15:47	-1	-0.25	0.18	0.25	-0.57	-0.44
7	16:34	-1	-0.1	0.18	0.25	-0.57	-0.44
7	17:33	-1	-0.6	0.18	0.25	-0.57	-0.44
7	18:37	-1	-0.2	0.18	0.25	-0.57	-0.44
7	20:25	1	0.5	3.88	3.95	-0.57	-0.44
7	21:15	1	1.4	4.78	4.88	-0.57	-0.44
7	22:06	1	0.4	4.98	5.05	-0.57	-0.44
300	09:30	1	1.9	6.16	6.16	-2.1	-2.1
300	10:55	-1	-4.9	4.81	4.81	-2.1	-2.1
300	12:14	-1	-3.6	0.81	0.81	-2.1	-2.1
300	13:11	-1	-2.7	-0.19	-0.19	-2.1	-2.1
300	13:54	-1	-2	-0.69	-0.69	-2.1	-2.1
300	14:35	-1	-1.7	-1.04	-1.04	-2.1	-2.1
300	15:38	-1	-1	-1.19	-1.19	-2.1	-2.1
300	16:27	-1	-1.1	-1.24	-1.24	-2.1	-2.1
300	17:26	-1	-0.6	-1.29	-1.29	-2.1	-2.1
300	18:25	1	1.5	-0.69	-0.69	-2	-2
300	20:16	1	2.2	3.61	3.61	-2	-2
300	21:06	1	1.8	5.89	5.89	-2	-2

300	21:55	1	0.2	5.29	5.29	-2	-2
8	10:03	1	0.8	5.97	5.97	1.37	1.61
8	11:14	-1	-4.7	4.59	4.08	1.37	1.61
8	12:33	-1	-3.5	3.69	3.28	1.37	1.61
8	13:27	-1	-2.6	3.44	3.16	1.37	1.61
8	14:09	-1	-2.7	3.28	3.08	1.37	1.61
8	14:48	-1	-2.3	3.14	2.88	1.37	1.61
8	15:52	-1	-1.8	2.99	2.78	1.37	1.61
8	16:38	-1	-1.7	2.89	2.78	1.37	1.61
8	17:37	-1	-1.1	2.86	2.73	1.37	1.61
8	18:45	-1	-1.4	2.84	2.73	1.37	1.61
8	20:32	1	0.8	4.19	4.18	1.37	1.61
8	21:22	1	1.4	5.09	5.03	1.37	1.61
8	22:12	1	0.5	5.23	5.18	1.37	1.61
9	10:14	1	1.9	5.45	5.68	2.87	2.39
9	11:22	-1	-2.8	5.18	4.58	2.87	2.39
9	12:38	-1	-1.6	4.79	3.73	2.87	2.39
9	13:32	-1	-1.5	4.45	3.48	2.87	2.39
9	14:15	-1	-2	4.22	3.28	2.87	2.39
9	14:51	-1	-1.7	4.03	3.18	2.87	2.39
9	15:58	-1	-0.8	3.81	2.98	2.87	2.39
9	16:45	-1	-1.3	3.73	2.88	2.87	2.39
9	17:42	-1	-1.1	3.68	2.83	2.87	2.39
9	18:49	-1	-1.2	3.63	2.83	2.87	2.39
9	20:38	1	2.1	4.18	4.28	2.87	2.39
9	21:27	1	2	4.83	5.03	2.87	2.39
9	22:20	-1	-0.1	5.03	5.08	2.87	2.39

PHILQUAL.WK1 PHILBRICK CULVERTS
TOWN OF RYE SALT MARSHES NAI PROJECT #4119
WATER QUALITY SURVEY 3-16-88

DRAFT FOR REVIEW ONLY - DATA SUBJECT TO REVISION

STATION	TIME	DIRECTION	TEMP	COND	SAL
10	10:23	1	3.9	29000	31.1
10	11:25	-1	4.5	29000	29.6
10	12:43	-1	5.5	28100	28
10	13:35	-1	6	24100	21.1
10	14:18	-1	6	17800	16.9
10	14:54	-1	7	15000	12
10	16:00	-1	5.5	10100	9.5
10	16:47	-1	5	8900	8.2
10	17:45	-1	3.2	7400	7.2
10	18:53	-1	2	5000	7
10	20:41	1	2.5	2100	2
10	21:29	1	3	22500	28.8
10	22:22	1	3	26000	27.6
11	10:32	1	4	16500	17
11	11:32	-1	5.2	17400	17.3
11	12:48	-1	5	9	8.5
11	13:41	-1	5.8	6100	5.5
11	14:24	-1	5	6600	5
11	15:00	-1	5.8	5000	4.2
11	16:07	-1	3	3300	3.1
11	16:53	-1	3	3100	3.3
11	17:51	-1	2	3000	3.1
11	19:10	-1	2	2600	3
11	20:50	-1	1	2900	2.8
11	21:35	1	1.5	3000	3
11	22:30	1	1	3700	3.5
7	09:57	-1	3.5	29000	30.9
7	11:11	-1	5	30000	31
7	12:27	-1	6.9	22700	21.1
7	13:21	-1	6.9	20000	18.6
7	14:05	-1	6.5	19400	18.1
7	14:43	-1	6.1	19200	17.1
7	15:47	-1	5.5	19000	18.1
7	16:34	-1	4.9	19800	17
7	17:33	-1	4	18000	17.3
7	18:37	-1	4	18000	16.9
7	20:25	1	4	28900	29.5
7	21:15	1	3	29000	30.4
7	22:06	1	3	29000	30.6
8	10:03	1	3.4	28750	30.9
8	11:14	-1	4.7	26500	27.8
8	12:33	-1	5.9	22000	21.2
8	13:27	-1	5.9	17900	17
8	14:09	-1	6.4	15000	13.8
8	14:48	-1	7	12700	11.2
8	15:52	-1	5.2	8100	7.3
8	16:38	-1	5	5800	5
8	17:37	-1	4.1	4000	3.8
8	18:45	-1	4	2700	3
8	20:32	1	3.5	27000	28
8	21:22	1	3.5	28100	30
8	22:12	1	3	28600	30.5

9	10:14	1	4	28900	31
9	11:22	-1	4.8	28900	29.5
9	12:38	-1	5.6	25800	25.1
9	13:32	-1	6.2	20700	19.2
9	14:15	-1	6	18100	16.9
9	14:51	-1	6.2	14700	14.5
9	15:58	-1	5.3	9000	8.1
9	16:45	-1	5	6000	5.3
9	17:42	-1	4.5	3100	3.2
9	18:49	-1	2.9	2000	2.6
9	20:38	1	1	10000	8.1
9	21:27	1	3	26200	28
9	22:20	-1	3.6	27100	28.5
300	09:30	1	3	28900	30.7
300	10:55	-1	4	29200	30.4
300	12:14	-1	5.2	28600	28.8
300	13:11	-1	5.8	25100	24.6
300	13:54	-1	6.6	22000	20.8
300	14:35	-1	6.8	19500	18.1
300	15:38	-1	6.5	17200	15.9
300	16:27	-1	5.9	14800	13.9
300	17:26	-1	5.4	12600	11.8
300	18:25	1	4.5	26000	26.1
300	20:16	1	3	29000	31
300	21:06	1	3	28900	31
300	21:55	1	2.9	29000	31.4